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PART VI

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

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OCCUPATIONAL EXPOSURE TO BENZENE

Emergency Temporary Standards; Hearing

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

[29 CFR Part 1910]

[Docket No. H–059]

OCCUPATIONAL EXPOSURE TO BENZENE

Proposed Standards and Notice of Hearing

AGENCY: The Occupational Safety and Health Administration, Department of Labor.

ACTION: Proposed rule and notice of hearing.

SUMMARY: The Occupational Safety and Health Administration (OSHA), in the FEDERAL REGISTER issue of May 3, 1977 (42 FR 22516), published an Emergency Temporary Standard (ETS) regulating worker exposure to benzene. The basis for that ETS was clinical and epidemiological data, some of which was only recently received, that conclusively established that benzene causes leukemia in humans. By this notice, OSHA proposes a permanent standard for the regulation of benzene. The proposed standard provides, as does the ETS, for a permissible employee exposure limit of one part benzene per million parts of air (1 ppm) averaged over an eight-hour period, with a 5 ppm ceiling limit, and proposes to limit eye and skin exposure. The proposal also requires, among other things, measurements of employee exposure, certain methods of compliance, personal protective equipment, employee training, work practices, medical surveillance, signs, labels, and recordkeeping. The permanent standard will supersede the existing ETS at the conclusion of the rulemaking.

DATES: Comments and Notices of Appearance concerning the proposed rule must be postmarked on or before June 27, 1977; all materials which will be introduced into the hearing record must be received by July 11, 1977; an informal hearing is scheduled to begin July 19, 1977.

FOR FURTHER INFORMATION CONTACT:

Mr. James Foster, Office of Public Affairs, OSHA, Third Street and Constitution Ave, NW, Room N3641, Washington, D.C. 20210, 202–523–8151.

SUPPLEMENTARY INFORMATION:

I. BACKGROUND

In the May 3, 1977 issue of the FEDERAL REGISTER, OSHA published an Emergency Temporary Standard (ETS) regulating benzene exposure in the workplace (29 CFR 1910.1028). That ETS, and the preamble explaining the reasons therefor, are incorporated herein in their entirety and annexed hereto for the convenience of all interested parties.[1] A correction document was published on May 10, 1977 (42 FR 23601). In the FEDERAL REGISTER for May 24, 1977, at 42 FR 26429, an amendment to the ETS is published. Pursuant to sections 6(b), 6(c) and 8(c) of the Occupational Safety and Health Act of 1970 (the Act) (84 Stat. 1593, 1596, 1599; 29 U.S.C. 655, 657), the Secretary of Labor's Order No. 8–76 (41 FR 25059) and 29 CFR Part 1911, it is now proposed to amend Part 1910 of 29 CFR by revising 29 CFR 1910.1028 (42 FR 22516).

This proposal applies to all employments in all industries covered by the Act that include "general industry," construction and maritime. One of the major issues involved in this proceeding is whether the final standard should exempt certain specified operations from its coverage. For the purpose of raising this issue, the proposal, as drafted, does not cover storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from a bulk terminal, and operations in which the only exposure to benzene is from liquid mixtures which contain no more than 0.1% benzene (1% benzene during the first year after the effective date of the standard). The question of whether these types of operations should be exempted is raised herein, and some of the reasons for the suggested exclusion of these operations are set out below. If these operations are excluded from the final standard issued as a result of this rulemaking, they would still be covered by the existing benzene standard in § 1910.1000. OSHA seeks public comment and evidence on these issues.

Other major issues raised in the proposal on which comment from the public is requested include the following:

1. Whether the proposed permissible exposure limit of 1 ppm is the minimum feasible exposure limit for all industries of whether a lower level should be required in the final standard.

2. Whether OSHA should consider different levels of exposure for industries which can feasibly reduce these levels below those that could be achieved by other industries.

3. Whether the ceiling level of 5 ppm and the prohibition against eye contact and repeated skin contact are sufficiently protective.

4. Whether the provisions for methods of compliance, regulated areas, medical surveillance, personal protective equipment and clothing, and recordkeeping are appropriate.

5. Whether the provisions for warning signs and labels and training-education program are appropriate and fully apprise employer of the leukemia hazard.

6. What, if any hygiene facilities, such as housekeeping, waste disposal, clothing laundering, should be required.

7. Whether the exclusion of activities related to storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to the discharge of such gasoline from bulk terminals is appropriate. If not, what requirements should be instituted.

8. Whether benzene can feasibly be removed from solvents and other products, and what exposures are associated with benezene contents below 1%.

9. What requirements, if any, should be established where, as a result of the medical surveillance program, it is determined that an employee is at an increased risk. What circumstances would arise if a rate retention requirement is subsequently adopted by OSHA for general application in health standards.

10. What are the environmental and economic impacts of this proposal.

11. Whether compliance with the proposal would be technologically and economically feasible for all affected industries, and particularly for employers with small numbers of employees.

12. How protection should be provided to employees where there are potentially conflicting standards. For example, coke oven workers are exposed to both coke oven emissions and benzene: however, certain provisions of the standard to control exposure to coke oven emissions, such as the respirator requirements may not be effective in controlling benzene exposure and vice versa.

In the development of this proposal, OSHA has considered recommendations and data received from the National Institute for Occupational Safety and Health (NIOSH), Department of Health, Education, and Welfare, as well as numerous reference works, studies, case histories, and journal articles, some of which are included in the reference section of the ETS. The discussions in the ETS concluding that benzene is a leukemogen to humans will not be repeated here. However OSHA has placed into the record the updated NIOSH report of the data from the Goodyear Tire and Rubber Company (dated April 28, 1977), an earlier version of which was referenced by the ETS as reference 51. The updated report again confirmed the findings that the workers, exposed to benzene during Pliofilm operations, had at least a seven times increase in the risk of contracting the malignant disease leukemia.

II. PERTINENT LEGAL AUTHORITY

The primary purpose of the Act is to assure, so far as possible, safe and healthful working conditions for every working man and woman. One means prescribed by Congress to achieve this goal is the authority vested in the Secretary of Labor to set mandatory safety and health standards.

Occupational safety and health standards provide notice of the requisite conduct or exposure level and provide a basis for assuring the existence of safe and healthful workplaces. The Act provides that:

> The Secretary, in promulgating standards dealing with toxic materials or harmful physical agents under this subsection, shall set the standard which most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life. Development of standards under this subsection shall be based upon research, demonstrations, experiments, and such other information as may be appropriate. In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be the latest available scientific data in the field, the feasibility of the standards, and experience gained under this and other health and safety laws. (Section 6(b)(5))

[1] See Appendix D.

Sections 2(b) (5) and (6), 20, 21, 22, and 24 of the Act reflect Congress' recognition that conclusive medical or scientific evidence including causative factors, epidemiological studies or dose-response data may not exist for many toxic materials or harmful physical agents. Nevertheless, standards cannot be postponed because definitive medical or scientific evidence is not currently available. Indeed, standards need only be supported by the best available evidence. The legislative history makes it clear that "it is not intended that the Secretary be paralyzed by debate surrounding diverse medical opinion." House Committee on Education and Labor, Report No. 91–1291, 91st Cong., 2d Sessions, p. 18 (1970). This Congressional judgment is supported by the courts which have reviewed standards promulgated under the Act. In sustaining the standard for occupational exposure to vinyl chloride (29 CFR 1910.1017), the U.S. Court or Appeals for the Second Circuit stated that "it remains the duty of the Secretary to act to protect the working man, and to act even in circumstances where existing methodology or research is deficient. *Society of the Plastics Industry Inc.* v. *Occuptional Safety and Health Administration*, 509 F. 2d 1301 (C.A.2 1975), cert den sub nom, *Firestone Plastic Co.* v. *United States Department of Labor*, 95 S. Ct. 1998, 4 L.Ed. 2d 482 (1975).

A similar rationale was applied by the U.S. Court of Appeals for the District of Columbia Circuit in reviewing the standard for occupational exposure to asbestos (29 CFR 1910.1001). The Court stated that:

> Some of the questions involved in the promulgation of these standards are on the frontiers of scientific knowledge, and consequently as to them insufficient data is presently available to make a fully informed factual determination. Decision-making must in that circumstance depend to a greater extent upon policy judgments and less upon purely factual judgments.

Industrial Union Department, AFL–CIO v. *Hodgson*, 499 F. 2d 467, 474 (C. A. D. C.1974).

In setting standards, the Secretary is expressly required to consider the feasibility of the proposed standards. Senate Committee on Labor and Public Welfare, S. Rep. No. 91–1282, 91st Cong., 2d Sess., p. 58 (1970). Nevertheless, considerations of technological feasibility are not limited to devices already developed and in use. Standards may require improvements in existing technologies or require the development of new technology. *Society of the Plastic Industry, Inc.* v. *Occupational Safety and Health Administration*, supra at 1309.

Where appropriate, the standards are required to include provisions for labels or other forms of warning to apprise employees of hazards, suitable protective equipment, control procedures, monitoring and measuring of employee exposure, employee access to the results of monitoring, and appropriate medical examinations. Moreover, where a standard prescribes medical examinations or other tests, they must be made available at no cost to the employees (section 6(b)(7)). Standards may also prescribe recordkeeping requirements where necessary or appropriate for enforcement of the Act or for developing information regarding occupational accidents and illnesses (section 8(c)).

III. Summary and Explanation of Additions to or Modifications of the ETS

The requirements imposed by OSHA in the ETS were those requirements that OSHA considered essential and feasible for employers to meet immediately, pending the development of a permanent standard. The preamble to the ETS explains the purpose and rationale for the provisions of the ETS. The following sections discuss any changes or additions that have been made in this proposal, changes or additions that OSHA believes are more appropriate for a final, permanent standard regulating employee exposure to benzene.

A. *Scope and application.* In the ETS and its subsequent amendments, OSHA exempted storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to the discharge of such gasoline from bulk terminals, and exposure to liquids containing benzene in amounts of 1 percent or less by volume.

OSHA recognizes the need for development of appropriate equipment control devices to reduce the loss of gasoline vapors containing benzene. OSHA also recognizes that, while the scope of its statutory obligations may be different than those of the Environmental Protection Agency (EPA), that Agency has a rich background of knowledge in the area of engineering control of hydrocarbon vapors. OSHA announces that it is in the process of establishing with EPA and NIOSH a joint federal agency taskforce to coordinate efforts in reducing worker exposure to benzene in retail automotive gasoline stations, and certain other aspects of transportation, storage, distribution and sale of gasoline and other motor fuels, if the facts warrant. OSHA will decide as a part of this rulemaking whether to include these employers in the final, permanent standard on benzene, to commence an independent rulemaking proceeding concerning worker exposure to benzene at these workplaces or to take other appropriate regulatory action in conjunction with EPA. OSHA is seeking the widest possible public input regarding the appropriate regulatory mechanism for protecting employees exposed to benzene at retail automotive gasoline stations, and during activities related to storage, transportation, and distribution of gasoline. Since other hazardous substances, such as asbestos, are present in gasoline stations, one regulatory option would be a "vertical" standard on all occupational hazards in retail gasoline stations. Moreover, OSHA desires comment on whether certain protective requirements should be included in any standard applying to gasoline stations and related activities, for example limiting use of gasoline as a solvent in such workplaces, and requiring information and training of employees.

As to liquids containing a certain percentage of benzene, the ETS did not apply where the only benzene exposure was from liquids containing benzene in amounts of 1 percent or less by volume. Benzene is a contaminant as well as an additive in a multitude of industrial substances; for example, benzene is found in toluene, gasoline, xylene, petroleum naphthas, and other hydrocarbon derivatives. The degree of benzene contamination in these and other materials is variable depending upon the practices of individual refineries and the material specifications established by many large volume solvent purchasers.

The ETS excluded mixtures containing 1 percent or less benzene by volume based upon OSHA's concern for the feasibility of requiring employers to implement such regulatory activities in so large a number of establishments in a short period of time. Moreover, there is some evidence that employee exposures to these substances are generally less than 1 part per million. However, in this proposal for a permanent standard, OSHA believes that a more careful consideration of this issue is necessary. There is only limited evidence which serves to correlate the potential exposure levels with the amount of benzene contaminant in solvent mixtures. As pointed out in the ETS, there is some indication that exposures resulting from the use of mixtures containing less than 1 percent benzene will generally be less than 1 part per million. However, it is not clear that this would always be the case.

The Arthur D. Little study of technological feasibility and economic impact presents a summary of the data on the benzene content of various solvents and employee exposures that reportedly result from the use of these solvents; for example, within the rubber industry employee exposure to benzene during tire building operations ranges from 1 to 3 parts per million on an 8-hour time weighted average basis. These exposure result from the use of petroleum naptha (white gasoline) which contains benzene in amounts ranging up to 4 percent by volume.

There appears to be no safe level for exposure to a carcinogen, and particularly as to benzene, as pointed out in the ETS. However, benzene is a widespread contaminant in industrial substances and is present in a large number of workplaces. As noted above, there is limited evidence presently available to predict the exposure that would typically result from the use of many of these substances. OSHA recognizes that the lower the benzene content, generally the lower the worker exposure. Consistent with its general policy of limiting exposure to carcinogens to the lowest feasible level, OSHA intends to exempt from the permanent standard only those substances for which the benzene content has been reduced to the greatest extent feasible.

Therefore, OSHA is proposing a step-down procedure exempting those workplaces in which employee exposure to benzene occurs only from liquids containing benzene of 1% or less with a reduction of that percentage to 0.1% benzene after 1 year. OSHA believes that the 0.1% exemption will result in worker exposures below the permissible exposure limit. This period of time is considered necessary to permit reformulation of products containing benzene, substitution, and disposal, perhaps by use, of existing stocks of products already in the channels of trade.

B. *Methods of compliance.* This proposed standard would require the employer to institute engineering and work practice controls to reduce employee exposures to or below the permissible limits. In situations where immediately implemented engineering and work practice controls that can be instituted immediately will not reduce exposures to the permissible exposure limit, these controls must nonetheless be used to reduce exposures to the lowest feasible level and be supplemented by respirators. In addition, a compliance program to reduce exposures to within the permissible exposure limits solely by means of engineering and work practice controls must be developed and implemented. Written plans for this program must be developed and be furnished upon request for examination and copying to representatives of the Secretary, representatives of the Director or affected employees. These plans must be reviewed and updated periodically to reflect the current status of the program.

Engineering controls are the preferred means of compliance because they reduce exposure hazards in the workplace environment by removing the airborne contaminant. Engineering controls may include the installation of local exhaust ventilation, modification of a process to as to reduce emission of the contaminant into the workplace, or substitution of another substance for benzene. Work practices often are necessary for the effective operation of engineering controls, and they therefore are also preferred as means of control.

Respirators are the least satisfactory means of control because of certain difficulties inherent in their use. Respirators are capable of providing good protection only if they are properly selected for the concentrations of airborne contaminants present, properly fitted to the employee, worn by the employee and replaced when they have ceased to provide protection. While it is theoretically possible for all of these conditions to be met, it is more often the case that they are not. As a consequence, the protection of employees by respirators is not always effective.

C. *Regulated areas.* Where employee exposure is in excess of the permissible exposure level, the employer must establish a regulated area. The purpose of establishing regulated areas is to limit the exposure to as few employees as possible. The burden on the employer is expected to be minimal since the provisions require the employer merely to identify and control access to regulated areas and to notify the applicable OSHA area office of their existence and conditions therein.

D. *Medical surveillance.* The proposal requires more thorough and sensitive laboratory blood tests than did the ETS. The additional tests will permit more comprehensive evaluation of hematopoetic functions and thereby increase the detection of bone marrow toxicity. In particular, the reticulocyte assay, a sensitive means of estimating changes in red cell production, may indicate impairment of the marrow when other indices appear normal, such as in the case of subtle anemias. Likewise, serum bilirubins provide a means of detecting early phases of benzene-induced anemia which may be hemolytic in nature. There is not complete agreement as to which parameter of hematologic function is the first indicator of benzene intoxication resulting from chronic low-level exposure to benzene. Therefore, OSHA believes that these blood tests need to be conducted on a quarterly basis. OSHA has accepted this recommendation based upon the Agency's view that this frequency is adequate to detect changes in the components of the blood which indicate benzene intoxication, while not placing an inappropriate burden upon the employer or the employee. OSHA requests, however, detailed comments on this issue.

E. *Rate retention.* The proposed standard does not include a provision prohibiting the exposure of an employee to benzene if the employee would be placed at increased risk of material impairment of his or her health from such exposure. Nor does the proposal include any provision requiring the transfer of such an employee to another job, or providing that removal for medical reasons should not result in loss of earnings or seniority status to the affected employee. Provisions of this type have been referred to collectively as rate retention and mandatory removal.

The Coke Oven Emissions standard (41 FR 46742 at page 46780, October 22, 1976) addresses the major considerations which must be dealt with in determining how to treat this issue. The conclusion reached by OSHA in that document is that:

> * * * further exploration of this (the rate retention) issue is necessary in order to deal in considerably more depth with the numerous issues raised by such a provision. It is therefore our intention to conduct further study, through an Advisory Committee or other means of the need and implications of rate retention as an aspect of an OSHA health standard. On the basis of this study, the Agency will take further action under the Act, as appropirate, regarding rate retention."

In the meantime, with respect to the benzene proposal, OSHA specifically invites comment on the issues of the propriety, scope and implications of a rate retention requirement in this standard, including: the number of employees who would be at increased risk from exposure to benzene at levels below the permissible exposure limit; the range of rate retention provisions available and their relation to determining when a condition is caused by agents other than benzene and, if so, whether an employer should be responsible for such an employees' retention of pay rate where the condition results in transfer or mandatory removal; the impact of such a provision on the affected industries; and possible alternatives to employee withdrawal.

F. *Labels.* Due to the hazardous nature of benzene, OSHA believes that emphasis should be placed on warning employees and other persons about the danger of exposure to benzene. For this reason, the ETS included a section requiring signs.

For the same reason, this proposal includes a requirement that caution labels be affixed to all containers of benzene and of the products containing benzene, not only because of the hazardous nature of benzene exposure, but because of the related necessity for both the employer and employee to know whether the product contains any benzene. The labeling provision also requires the employer to assure that caution labels are affixed to any product containing benzene when such product leaves the employer's workplace. This proposed requirement is designed to protect any other employees who will be handling, transporting, or using this product. Thus manufacturers and suppliers would be required to affix caution labels. The rationale for this requirement would be that the manufacturer or supplier is in the best position to know whether the product does contain benzene.

G. *Recordkeeping.* The proposed standard requires the employer to keep written records of employee exposure measurements and medical examinations. Symptoms of leukemia may not appear for many years after the last exposure to benzene. Thus, records of exposure measurements and medical examinations should be retained for a definite period of years even after the employee ceases to work. For this reason, the recordkeeping provisions of the proposal require the employer to retain these records for at least 40 years, or for the duration of employment plus 20 years, whichever is longer.

IV. Conclusions

OSHA recognizes that many of the matters considered in this proposal are controversial and that some gaps may exist in the available scientific evidence. OSHA has concluded that benzene is extremely harmful to workers. The unavailability of certain limited scientific evidence cannot legitimately delay the proposal of a permanent standard for protecting workers exposed to benzene. OSHA hopes that the public participation in this rulemaking will help to fill whatever gaps exist.

Therefore, based on the best available evidence and in view of the statutory requirement that no employee suffer material impairment of health or functional capacity as a result of exposure to toxic substances, OSHA believes that employee exposures to benzene must be reduced to the lowest level feasible and

that the other requirements to regulate exposure to benzene must be imposed, as set forth in the proposal. After the rulemaking record is closed, OSHA will evaluate all the evidence received and issue a final permanent standard based on the entire record.

V. Technological Feasibility Assessment and Economic Impact Statement

Pursuant to section 6(b) of the Occupational Safety and Health Act and in accordance with Executive Order No. 11949 (42 FR 1017, January 5, 1977), OSHA contracted for and received a technological feasibility assessment and economic impact statement from Arthur D. Little Company. This statement has been reviewed and OSHA concludes that the proposed regulation of benzene is a "major" action. The Assistant Secretary certifies that the economic impact of this proposal has been evaluated.

This statement along with all other references cited and other relevant material, are available for inspection and copying at the OSHA Technical Data Center, Room S6212, Third St. and Constitution Avenue, NW., Washington, D.C. 20210. OSHA invites comments on any of the information contained or conclusions reached, in the statement concerning technological feasibility and economic impact.

VI. Environmental Impact

The preceding description of the proposed standard and its supporting rationale together with that found in the annexed ETS, as well as the following sections on environmental impact, constitute OSHA's draft environmental impact statement on the proposed standard for occupational exposure to benzene.

This statement has been prepared in accordance with the provisions of the National Environmental Policy Act (42 U.S.C. 4321 et. seq.) as well as the guidelines of the Council on Environmental Quality (40 CFR Part 1500) and OSHA's regulations (29 CFR Part 1999). The purpose of this draft environmental impact statement is to aid in the Agency decision making on proposed actions which may have the potential for significantly affecting the quality of the human environment. Written comments and information on the projected impacts of this proposed standard for exposure to benzene are solicited from any interested persons or groups during the period for written comment submissions listed below in this Notice.

In addition to this general request for comment, copies of this proposal and environmental impact statement will be sent to numerous Federal and State agencies, industry representatives, employee unions; and public interest groups with requests for their comments. A copy of this listing is available in the OSHA Technical Data Center, Room S-6212, Department of Labor, Third Street and Constitution Avenue, NW., Washington, D.C. 20210.

Testimony, data, arguments, and related submissions will be received at the public hearing to be held on this proposed standard on July 19, 1977, provided prehearing submission requirements, also outlined below, are complied with.

Additional copies of this proposed standard and draft environmental impact statement are available for review and copying in the OSHA Technical Data Center.

Alternatives

There are three major areas of regulatory decision making which will affect the impact of the benzene standard on the external environment. These are: (1) the scope and application of the regulation, (2) the airborne permissible exposure limit, and (3) the methods by which compliance is mandated. The purpose of this section is to present the alternatives available. The discussion of the impact of each of these alternatives will be in the following section.

(1) *Scope and application.* The emergency temporary standard (ETS) applied to all establishments in which benzene is present, including "general industry," construction, and maritime. The ETS did not apply, however, to storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from bulk terminals nor to operations utilizing liquid mixtures containing 1 percent or less benzene by volume.

This proposal applies to "general industry," construction and maritime. It has retained the exclusion for the storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from bulk terminals. Although the proposal retains the ETS exemption of those operations utilizing liquids containing less than 1.0 percent benzene by volume, this exemption would be in effect only for one year. Thereafter, only operations containing 0.1 percent or less benzene by volume would be exempted.

Other options available to OSHA include elimination of the percentage exclusion or the expansion of coverage to retail automotive service stations and a broader range of gasoline industries. Conversely, OSHA could further restrict the scope of the regulation.

(2) *Permissible exposure limit.* The previous OSHA permanent standard for benzene, in effect prior to the issuance of the ETS, prescribed an 8-hour time weighted average (TWA) of 10 ppm with an acceptable ceiling concentration of 25 ppm. In addition, it allowed excursions above the ceiling to a maximum peak concentration of 50 ppm, provided that this peak occurred for no more than 10 minutes in any 8-hour work period. This standard was based largely on benzene's general toxicity rather than on its leukemia hazard.

The proposal establishes an airborne permissible exposure limit (PEL) of 1 ppm with a ceiling limit of 5 ppm exposure averaged over any 15 minute period. The proposal additionally prohibits eye contact and repeated skin exposure to liquid benzene.

The PEL adopted by this proposal was chosen not as a "safe" or "no effect" level, but on the basis of OSHA's belief that 1 ppm is the lowest level that generally can be achieved. OSHA is mandated by the Act to consider feasibility in setting regulations. However, it is possible that a level lower than 1 ppm could be shown to be feasibly attained either by existing controls or by the development of new controls. In that case, OSHA has the option to regulate to whatever level below 1 ppm is determined to be appropriate.

Another regulatory alternative is to adopt differing standards for different industries, moderating the degree of regulation as deemed necessary for adequate and feasible protection of workers in the various industries where benzene is present.

(3) *Methods of compliance.* OSHA's regulation, 29 CFR 1910.1000, under which benzene was initially regulated, provided that compliance be achieved first through administrative or engineering controls, whenever feasible, and, when such controls were not feasible, through the use of supplementary protective equipment.

This proposal requires the institution of engineering and work practice controls to reduce exposure to or below the PEL. In addition, the proposal requires that a program be established and implemented to reduce exposures to or below the PEL, solely by means of engineering and work practice controls. Protective clothing and equipment are also required where necessary to prevent eye contact or repeated skin contact.

Engineering controls may include the installation of local exhaust ventilation, modification of a process so as to reduce emissions, or substitution of another substance for benzene.

Alternatives involved in the compliance section of the regulation are primarily concerned with establishing a particular priority among the types of controls (engineering, work practice, and respiratory protective equipment). Sole reliance on engineering controls or on use of engineering and work practices equally could be required. Another alternative would allow the employer complete freedom in choosing the method of control without any required priority systems. An alternative approach would be to specify controls, such as reformulation of products to decrease benzene content, or the preferential use of vapor recovery systems over ventilation.

Additionally, there are other areas in which alternative actions might variously have impact upon what is considered the external environment. One of these areas is medical surveillance. The ETS provided for the minimum tests considered necessary to determine the effects of exposure to benzene. This proposal requires a more comprehensive evaluation and more sensitive means of detecting changes which may indicate effects of exposure.

It is clear that there are numerous areas with various regulatory approaches which may have differential effects on some aspects of the external environment. The possible impacts of these ap-

proaches will be discussed in the following chapter.

PROJECTED IMPACTS

The primary effect of this regulation is expected to impact on the workplace by reducing worker exposure to benzene. A second potential impact may occur to the environment external to the workplace.

The impacts on workers and the work environment of OSHA's proposed regulation of benzene has already been treated in the preceding chapters of this preamble and the preamble to the ETS. This section will attempt to delineate the impacts of the proposed rule on the external environment and will also consider the potential impacts of alternative regulatory measures and various compliance methods.

A standard for control of occupational exposure to benzene has the potential for affecting the external air quality, water quality, waste disposal (a function of land use, air quality and water quality), energy consumption, and human resources. Economic costs of implementing an occupational health standard have also been determined to have the potential for impacting the general human environment. A brief discussion of these particular impacts is included in this statement. For further information, the Technological and Economic Impact Assessment on Benzene prepared for OSHA by Arthur D. Little Inc. should be referred to. It is available at the OSHA Technical Data Center.

The specifics of potential impacts expected as a result of OSHA's proposed regulation and of alternatives to that regulation will be addressed in this chapter. But initially an overview will be presented to give a general idea of the types of impacts which may result, and the ways in which they depend on the various alternatives involved in the regulatory decision making and subsequent choice of compliance methods.

The first area of alternatives is in the scope and application of the regulation. One option is the inclusion or exemption of storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from bulk terminals. The areas of the external environment which will be impacted by this choice are air quality and human resources. The impacts on water quality, solid waste, and energy consumption would be insignificant, if any were to result at all, for the ways in which OSHA regulation would effect this segment would be to control vapor release and to provide medical surveillance of employees.

The direcion of the impact would be improvement of the ambient air quality by reduction of contamination of the employees' breathing air. It is reasonable to expect that it would be necessary to control exposure through engineering controls, resulting in containment of benzene at the source.

To the extent that monitoring and medical surveillance of employees is required, there will be an impact on medical resources and the supply of industrial hygienists. The full extent of this impact cannot be readily quantified.

The second area of alternatives is in setting the permissible exposure level (PEL). This area is integrally related to the methods of compliance (the third area of alternatives) used to achieve control of exposure to or below the PEL. The choice of alternative PEL's and of compliance is expected to have impact in some way on almost every category of the external environment.

In a general sense, reduction of benzene exposure will involve engineering controls to prevent emissions at the source, work practices to prevent accidental spills and contacts with benzene, and good housekeeping procedures to cope with spills when they do occur. Respirators may also be used in some cases to prevent worker exposure to benzene vapor. An additional method of compliance is the substitution of some other substance for benzene.

The extent of engineering control required is to some extent relative to the level of exposure which must be met. If exposure is to be controlled by preventing leaks and evaporation, then the controls would have to be tighter and perhaps more extensive to meet the lower PEL. This would result in less workplace contamination and, thereby, lower ambient emissions. On the other hand, if control is achieved by ventilation, the amount of benzene contamination would remain constant but the rate of exhaust outside the plant would increase. This increased flow rate may not affect the ambient air quality, but might result in an insignificant increase in energy consumption.

Likewise, tighter engineering controls to achieve lower PELs would reduce the escape of benzene into the effluent discharge, representing a positive impact on water quality. Conversely, other means of control and their degree of effectiveness may result in increased contamination of water and increased sludge production, representing a potential negative impact on both water quality and the amount of solid waste.

The PEL and compliance methods chosen should have no effect on the amount of monitoring and medical surveillance required. However, the degree of impact on human resources will depend on the contents of monitoring and medical surveillance provisions.

A. AIR POLLUTION IMPACT

The importance of benzene in air pollution is related to the concern for long-term exposure to low levels by large numbers of people. Benzene's participation in the formation of photochemical oxidants is minimal, and as a result, it is generally omitted from control efforts to reduce the formation of photochemical oxidants. However, the evidence regarding the leukemia hazard of exposure to benzene must be taken into account in evaluating the environmental impact of this proposal.

The sampling for air pollutants has been largely concerned with the total hydrocarbon levels in the atmosphere. However, several studies summarized in Table I have been conducted to specifically evaluate benzene levels. These studies were carried out in Los Angeles, Toronto, Zurich and the Netherlands and the data in Table I indicates that the ambient benzene concentrations in the urban atmosphere are normally well below 0.1 ppm and have an average concentration of 0.01 ppm. In the Los Angeles, Toronto and Netherlands studies it was noted that the benzene concentrations found at sampling sites adjacent to major roadways were highly correlated with periods of heavy traffic volume. This suggests that the motor vehicle is a source of benzene in the community air as a result of both incompletely combusted exhaust emissions and direct evaporation from vehicle gas tanks.

TABLE I (4).—*Comparison of measurement results of several sites, concentrations in part per billion*

	Benzene	
	Maximum	Average
Los Angeles	57.0	15
Toronto	98.0	13
Zurich	74.0	35
Netherlands:		
Delft	8.0	1
The Hague	29.0	9
Tunnel [1]	82.2	25

[1] High traffic area.

Source: Modified from: Burghardt, E. and Jeltes, R., "Gas Chromatographic Determination of Aromatic Hydrocarbons in Air Using a Semi-Automatic Preconcentration Method, Atmospheric Environment," vol. 9, pp. 935-940.

1. *Production.* Mitre's estimates of the quantity of benzene currently lost during commercial production, storage and transport is 79 million pounds. These emissions are largely derived from petroleum cracking facilities which currently contribute approximately 95% of the nation's total output for benzene.(7). A report in the process of being published by EPA indicates somewhat smaller estimates.

Emissions from these production sources are related to a variety of operations including equipment repair and maintenance, clean-up of small spills, transfer of materials, and the normal operation of process equipment. Additional emissions result from blow down systems, waste water separators, cooling towers and storage facilities. Fugitive emission sources include leaking pumps and compressor seals, pressure relief valves, pipeline valves and flanges, changing pipeline blinds and purging sample lines. The relative magnitude of benzene emissions can be based in part upon the emission factors summarized in Table IV.(6). These data are representative of total hydrocarbon emissions, but are pertinent to the evaluation of benzene releases where it constitutes a portion of the process stream.

TABLE II (5).—*Benzene emissions to the environment—1971*

[In millions of pounds]

Source	Location	Quantity	Media of entry
Commercial benzene production, storage and transport.	Primarily southwest	79 (assumed 1 pct. of total production).	Air, water.
Commercial benzene usage	Primarily southwest and northeast.	658 (based on reaction yields)	Do.
Oil spills	Oceans and rivers	22-24	Water.
Motor vehicle emissions	Similar to population distribution.	1,000	Air.
Coke ovens	Primarily, North Central States and Alabama.	122 (1974)	Air.

Source: Modified from Walker, P., "Air Pollution Assessment of Benzene; Mitre Technical Report," MTR-7188 Mitre Corp.; McLean, Va., 1976.

TABLE III (6).—*Emission factors for petroleum refineries*

Type of process:	*Hydrocarbons*
Fluid catalytic cracking units (FCC):	
Pounds per thousand barrels fresh feed	220
Kilograms per thousand liters fresh feed	.630
Moving-bed catalytic cracking units (TCC):	
Pounds per thousand barrel fresh feed	87
Kilgrams per thousand liters fresh feed	.250
Blowdown systems:	
Pounds per thousand barrels refinery capacity—	
With control	5
Without control	300
Kilograms per thousand liters refinery capacity—	
With control	.014
Without control	.860
Process drains:	
Pounds per thousand barrels waste water—	
With control	8
Without control	210
Kilograms per thousand liters waste water—	
With control	.023
Without control	.600
Vacuum jets:	
Pounds per thousand barrels vacuum distillation—	
With control	[1]
Without control	130
Kilograms per thousand liters vacuum distillation—	
With control	[1]
Without control	.370
Cooling tower:	
Pounds per thousand gallons cooling water	6
Kilograms per thousand liters cooling water	.72
Miscellansous losses, pounds per thousand barrels refinery capacity: [1]	
Pipeline valves and flanges	28 (0.080)
Vessel relief values	11 (.031)
Pump seals	17 (.049)
Compressor seals	5 (.014)
Other (air blowing, sampling, et cetera)	10 (.029)

[1] Kilograms per thousand liters shown in parentheses.

TABLE IV (6).—*Hydrocarbon emission factors for evaporation losses from the storage of petroleum products*

Type of tank [1]	Units	Type of material stored: Gasoline or finished petroleum product	Type of material stored: Crude oil
Fixed roof breathing loss	Pounds per day—1,000 gal storage capacity	0.4	0.3
	Kilograms per day—1,000 l storage capacity	.05	.04
Working loss [2]	Pounds per 1,000 gal throughput	11	8
	Kilograms per 1,000 l throughput	1.32	.96
Floating roof breathing loss	Pounds per day—tank	[3]	[4]
	Kilograms per day—tank	63.5	45.4
Working loss	Pounds per 1,000 gal throughput	[5]	[5]
	Kilograms per 1,000 l throughput	[5]	[5]

[1] For tanks equipped with vapor-recovery systems, emissions are negligible.
[2] An average turnover rate for petroleum storage in approximately 6. Thus, the throughput is equal to 6 times the capacity.
[3] 140 (40 to 210). 140 (63.5) based on average conditions and tank diameter of 100 ft (30.5 m); use 40 (18.1 kg) for smaller tanks, 50 ft (15.3 m) diameter; use 210 (95 kg) for larger tanks, 150 ft (45.8 m) diameter.
[4] 100 (30 to 160). Use 30 (13.6 kg) for smaller tanks, 50 ft (15.3 m) diameter; use 160 (72.5 kg) for larger tanks, 150 ft (45.8 m) diameter.
[5] Negative.

The Compilation of Air Pollution Emission Factors published by the Environmental Protection Agency states, "There are essentially no emissions from reforming operations" in the petroleum refining industry. However, due to benzene's volatility there is a possibility that some environmental contamination occurs during these operations.

Promulgation of a 1 ppm level for benzene will have the effect of reducing overall emissions for benzene. This results because greater controls will be maintained over leaking process equipment and fugitive emissions. In this case there is an anticipated positive impact on the external environment of reduced benzene emissions from production sites.

2. *Storage and Transportation.* Since gasoline contains a certain amount of benzene, an alternative to the proposal would also affect gasoline storage and marketing facilities as well as firms distributing gasoline. Expected means of compliance would suggest that engineering controls possibly include internal floating roofs on storage tanks, bottom loading assemblies and vapor condensing and/or return equipment. Tables IV and V illustrate the expected hydrocarbon emission rates (a portion of these amounts are benzene) resulting from storage and transfer operations (6). The application of vapor return or recovery equipment, as well as internal floating roofs and bottom loading assemblies, will largely eliminate ambient emissions.

3. *Commercial Usage: Chemical Processing.* The chemical process industries utilizing benzene feedstock material were evaluated during the development of the Economic Impact Analysis (EIA) prepared for OSHA by Arthur D. Little. It was determined that these operations were largely in compliance with the previous OSHA standard due to the constraints of closed system operations and the economics of preventing possible losses of feedstock and products. Possible, though infrequent, over-exposures would be due to non-routine situations such as process upsets or equipment failure.

As with the benzene production facilities, engineering controls may be necessary to comply with a 1 ppm benzene standard. Controls would be very similar in type and extent to those used in the production facilities to reduce emissions during process operations and from fugitive sources. The reduction in process and fugitive losses may result in a significant, (though as yet unquantified) reduction in benezene emmissions and those of its process intermediates.

4. *Commercial Usage: Solvent Usage.* Another use of benzene is as an industrial solvent. Benzene has been largely removed from solvent applications, often being replaced by toluene, which, however, does contain a small percentage of benzene. Benzene is still found in a limited number of specialized low volume applications such as proprietary adhesives within the rubber industry, and in paint remover formulations.

The purpose of solvent materials is simply to provide a vehicle for solid materials to facilitate the application of solid materials. As such, much of the benzene used as solvent is lost by evaporation upon application. Only a limited number of processes within the adhesives and printing industries utilize vapor recovery equipment as a method of solvent recovery and recycling.

Exposure control of this compound in solvent application involves a variety of alternatives (7). Primary among the control alternatives would be general dilution and local exhaust ventilation systems and product reformulation to either reduce or remove the benzene component. These alternatives will be discussed separately for their possible environmental impacts.

A common method for protecting workers from solvent vapors is to provide adequate ventilation to both dilute the vapors with fresh air and to carry them out of the worker breathing zone. This approach to exposure reduction finds widespread application within industries having adhesive and coating solvent exposures. The necessary equipment and design knowledge for spray booth and ventilation-hood installations is readily available for these applications. In many cases, existing equipment can be adapted to achieve lower exposures by increasing

the velocity of the fans or reducing the area of the ventilation ducts or booth areas.

Since the purpose of ventilation equipment is to remove vapors from the work environment, once this task is accomplished, the exhausted air, including the vapors, is often emitted directly into the external environment. The vapor concentration in the exhaust is often so low that further treatment is considerably more difficult. When the exhaust air contains large amounts of particulate matter, as from a paint spray operation, or particularly malodorous vapors, air treatment becomes more necessary.

Increased ventilation will alter the rate at which benzene vapors are shunted to the atmosphere and could change the final impact on ambient levels of benzene. Where reformulation is practiced to reduce solvent usage, however, the atmosphere will realize a reduction in total hydrocarbon load. Therefore, if the OSHA regulation were to specify the control technology, there would be a basis for evaluating the possible changes in the benzene levels in the atmosphere.

The second general method to reduce benzene exposures is reformulation. In this approach other solvents may be substituted for either part or all of the benzene or the benzene contamination of other solvents reduced; equipment may be developed to utilize a higher solid content solution (i.e., less solvent per volume of material applied); solvent systems may be completely replaced with a water based and hot melt applications; or in extreme cases the process involving the solvent may be discontinued entirely. Analysis in the EIA demonstrates examples of each of these reformulation possibilities. The coatings industry is exploring possibilities of high solds and water based coating applications systems (*9*). Manufacturers of paint removers are substituting other solvents for benzene. Adhesives manufacturers are beginning to utilize other systems including substitution of solvents such as methyl ethyl ketone, water based systems and new solventless systems that are liquidified by heat and form the adhesive bond when they cool and solidify ("hot melt" adhesives) (*6*).

5. *Motor Vehicle Emissions.* While this is perhaps one of the most important sources of benzene emissions, it is excluded from this particular rule. The only segment of these emissions that may possibly be controlled by OSHA would be those affecting emplovee exposure resulting primarily from the filling of vehicle gas tanks.

B. WATER POLLUTION IMPACTS

The relatively moderate water solubility (compared to other hydrocarbons) (1780 mg/1 at 25°C) and vapor pressure (95.2 mmHg at 25°C) of benzene are important parameters in the determination of its potential for contamination of water. Because of its moderate solubility in water, benzene may be washed out of the atmosphere with rain. In combination with the evaporation process, this would result in a continuous cycling between air and water.

The three major industrial sectors having emissions which emit benzene to the aquatic environment appear to be: (1) chemical production and processing; (2) coating operations, and (3) storage-transportation.

While engineering controls would act to reduce leakage and spillage of compounds, work practice controls would tend to emphasize a prompt response to spills with flushing to waste chemical drains. From chemical drains in these plants the materials would proceed to oil separators where the organic materials are recycled to the production system.

Some amount of material, however, including benzene, might escape into the water effluent. (*15*) In comparison to the reduction of leaks and spills expected to result from the regulation, the potential increase in effluent emissions due to more efficient work practices is not expected to be significant. An overall reduction in emissions should result from the implementation of the regulation.

C. SOLID WASTE

As discussed previously, methods to comply with the proposed benzene regulation are largely aimed at preventing releases to the air and to a lesser extent to the water. Since the control measures largely involve work practices and durable equipment to either prevent or redirect vapor emissions, impacts upon solid waste loads are expected to be minimal if not completely negligible.

D. HUMAN RESOURCES IMPACTS

As stated earlier in this document, the intent of the OSHA standard for occupational exposure to benzene is to protect employees from the health hazards associated with such exposures. Health benefits resulting from control of benzene include prevention of blood and bone marrow poisoning as well as lowering the risk of leukemia. Reduced rates of industrial accidents and short term illnesses are also viewed as the proposed standard's beneficial impacts.

A possible further impact of the proposed standard is to increase the demand for limited medical resources. This will not be a major impact for those companies affected by the regulation which are large corporate concerns which already maintain a medical staff. However, smaller facilities may have to acquire the services of medical personnel, which could create an additional burden on the limited supply of industrial hygienists, nurses and doctors. This impact on human resources will be directly dependent on the scope of the final rule and could become significant if retail automotive service stations and to the storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from bulk terminals are ultimately included. A factor to be considered, however, is that reducing worker exposure to benzene is expected to result in improved health.

E. ENERGY

Within the scope of the proposed OSHA benzene standard the only activities requiring an increased energy demand would be increased ventilation and the resulting need to condition greater volumes of make-up air. The Arthur D. Little study (EIA) evaluates industry's compliance costs for engineering control to primarily result from tightening up production processes, and installing new hardware (i.e., rupture disks, floating roofs, vapor control systems and mechanical seals). Since engineering control requirements were based upon slight modification to existing inplant systems, the EIA judged increased energy consumption to be "negligible."

F. LAND USE

As enumerated in the EIA analysis, compliance activities for this regulation are expected to consist of modifications to existing control equipment and work practice controls where necessary. These modifications should be easily completed in existing areas and no additional land usage will result. The EIA demonstrates that changes in costs and productivity as a result of the OSHA regulation should be minimal (in most cases less than 0.5%). With these small changes it is not felt that the construction of new facilities because of productivity constraints can be justifiably attributed to the proposed OSHA standard.

G. ECONOMIC IMPACT

The EIA on benzene has estimated the costs and benefits of compliance with the proposed regulation (as well as other control scenarios).

In addition to cost of compliance estimated, the EIA also addresses the issue of expected price changes in products involving these materials.

RELATIONSHIP WITH OTHER FEDERAL ACTIONS

Workers exposed to benzene during industrial operations constitute that portion of the general population most exposed to its health hazards. Any OSHA standard to limit occupational exposure to benzene is written for their protection. However, since benzene is released to the ambient environment and has impacts on the environment external to the workplace, it is also a matter of concern to the Environmental Protection Agency (EPA) which is responsible for safeguarding air quality under the provisions of the Clean Air Act (as amended, 42 U.S.C. 1857 et seq.) and water quality under the provisions of the Water Pollution Control Act of 1972.

EPA was petitioned by the Environmental Defense Fund on April 14, 1977 to list benzene as an agent of concern under section 112 of the Clean Air Act no later than May 30, 1977. They are currently responding to this petition. If benzene is determined to be a hazardous air pollutant, the EPA would then be responsible for proposing a regulation within 180 days from the date of listing.

In its ongoing process of developing water pollution criteria, EPA is currently evaluating aquatic benzene toxicity. At the present time, benzene effluents are controlled as contributors to the total BOD load of industrial effluents. As such, OSHA regulations resulting in slightly more benzene effluent would not conflict with EPA water effluent standards as long as the total BOD (biological oxygen demand) level is controlled. While this relationship in regard to water emissions may change with future standard setting on the part of EPA, it is not expected to alter industry's approach to compliance with OSHA benzene regulations. Since benzene is normally only a portion of the effluent produced by a given industry and it does not offer any unusual problems during water treatment (3) compliance with EPA regulations can be expected to be within industry's capabilities.

The Consumer Product Safety Commission (CPSC) was petitioned on May 8, 1977 by the Health Research Group to ban and recall benzene-containing products by its authority under the Hazardous Substances Act. At this time the agency is reviewing the petition and does intend to respond.

Whatever possible action the CPSC might take should create no interference with OSHA's regulation of occupational exposure to benzene.

REFERENCES

(1) Seminar on Air Pollution from Motor Vehicles; Technical Coordination, Office of Air Programs, Environmental Protection Agency; 1972.1.

(2) Air Quality Criteria for Photochemical Oxidants; U.S. Department of Health, Education and Welfare, National Air Pollution Control Administration, No. AP-63, 1970.

(3) Air Quality Criteria for Hydrocarbons; U.S. Department of Health, Education and Welfare, National Air Pollution Control Administration, No. AP-64, 1970.

(4) Burghardt, E. and Jeltes, R.; Gas Chromatographic Determination of Aromatic Hydrocarbons in Air Using a Semi-Automatic Preconcentration Method; Atmospheric Environ., 9, 355-940; 1975.

(5) Walker, P.; Air Pollution Assessment of Benzene; Mitre Technical Report, MTR-7188; Mitre Corporation, McLean, Va.; 1976.

(6) Adapted from: Compilation of Air Pollution Emission Factors (Revised), U.S. Environmental Protection Agency, AP-42; 1972.

(7) Technology Assessment and Economic Impact Study of an OSHA Regulation for Benzene—Draft Report; for U.S. Department of Labor, Occupational Safety and Administration; Arthur D. Little, Inc., Cambridge, Mass., October 1976.

(8) Air Pollution Engineering Manual; Danielson, John A., ed.; Environmental Protection Agency, Research Triangle Park, N.C., 1973.

(9) Ellerhorst, H.; Energy Crisis; Catalyst for Change; Modern Paint and Coatings, p. 31-33; October 1975.

(10) Policy Statement on Use of the Concept of Photochemical Reactivity or Organic Compounds in State Implementation Plant for Oxidant Control, EPA Quality Office, January 29, 1976.

(11) Communication with Plant Manager of Durant Paints, Inc., Revere, Massachusetts.

(12) Communication with Plant Manager of Touraine Paints, Inc., Everett, Massachusetts.

(13) Howard, P. H. and Sustin, R. R.; Benzene: Environmental Sources of Contamination, Ambient Levels and Fate; Office of Toxic Substances, U.S. Environmental Protection Agency; EPA 560/5-75-005; December 1974.

(14) Blamer, M., Saunders, H. L., Grassle, J. F. and Hamson, G. R.; A Small Oil Spill; Environment, 13, 2-12; March 1971.

(15) Communication with Mr. J. L. Goodier, Bio-Enviro Section, Arthur D. Little, Inc., Cambridge, Massachusetts; December 1976.

(16) Communication with Mr. G. Hama; Industrial Hygienist, Wayne State University, Detroit, Michigan; December 1976.

VII. PUBLIC PARTICIPATION; NOTICE OF HEARING

Interested persons are invited to submit written data, views and arguments with respect to the ETS and this subsequent proposal. These comments must be postmarked on or before June 27, 1977, and submitted in quadruplicate to the Docket Officer, Docket H-059, Room S6212, U.S. Department of Labor, 3rd Street and Constitution Avenue, N.W., Washington, D.C. 20210. Written submissions must clearly identify the provisions of either the ETS, the proposal, or both which are addressed and the position taken with respect to each issue therein. The data, views and arguments that are submitted will be available for public inspection and copying at the above address. All timely written submissions received will be made a part of the record for this proceeding.

Pursuant to section 6(b)(3) of the Act, an opportunity to submit oral testimony concerning the issues raised by the ETS and the proposed standard, including the economic and environmental impacts, will be provided at an informal public hearing scheduled to begin at 9:30 a.m. on July 19, 1977, in the Auditorium, New Department of Labor Building, 3rd Street and Constitution Avenue, N.W., Washington, D.C., 20210.

NOTICES OF INTENTION TO APPEAR

All persons desiring to participate at the hearing, must file in quadruplicate, a notice of intention to appear, postmarked on or before June 27, 1977 with the OSHA Division of Consumer Affairs, Docket No. H-059, Room N-3635, U.S. Department of Labor, 3rd Street and Constitution Avenue, N.W., Washington, D.C. 20210 (telephone: (202) 523-8024). The notices of intention to appear, which will be available for inspection and copying at the OSHA Technical Data Center-Docket Office (Room S6212), telephone (202) 523-7894, must contain the following information:

(1) The name, address, and telephone number of each person to appear;

(2) The capacity in which the person will appear;

(3) The approximate amount of time requested for the presentation;

(4) The specific issues that will be addressed;

(5) A detailed statement of the position that will be taken with respect to each issue addressed; and

(6) Whether the party intends to submit documentary evidence, and if so, a brief summary of that evidence.

FILING OF TESTIMONY AND EVIDENCE BEFORE HEARING

Any party requesting more than 15 minutes for a presentation at the hearing, or who will submit documentary evidence, must provide in quadruplicate the complete text of testimony, including any documentary evidence to be presented at the hearing, to the OSHA Division of Consumer Affairs. This material must be received by July 11, 1977, and will be available for inspection and copying at the Technical Data Center—Docket Office. Each such submission will be reviewed in light of the amount of time requested in the notice of intention to appear. In those instances where the information contained in the submission does not justify the amount of time requested, a more appropriate amount of time will be allocated and the participant will be notified of that fact.

Any party who has not substantially complied with this requirement may be limited to a 15 minute presentation, and may be requested to return for questioning at a later time.

CONDUCT OF HEARINGS

The hearing will commence at 9:30 a.m. on July 19, 1977, with resolution of any procedural matters relating to the proceeding. The hearing will be conducted in accordance with 29 CFR Part 1911. In view of the ETS and its emergency nature, the hearing will be conducted in as expedited a manner as possible, consistent with a full development of the record and rights of the parties.

The hearings will be presided over by an Administrative Law Judge who will have all the powers necessary or appropriate to conduct a full and fair informal hearing as provided in 29 CFR Part 1911. Following the close of the hearing or of any post hearing comment period that might be provided, the Administrative Law Judge will certify the record to the Assistant Secretary of Labor for Occupational Safety and Health. The proposal will be reviewed in light of all oral and written submissions received as part of the record, and a standard will be issued based on the entire record in this proceeding.

VIII. AUTHORITY

This document was prepared under the direction of Eula Bingham, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, Third Street and Constitution Avenue, N.W., Washington, D.C. 20210.

Accordingly, pursuant to sections 4(b), 6(b), 6(c) and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1592, 1593, 1596, 1599, 29 U.S.C. 653, 655, 657), the Secretary of Labor's Order No. 8-76 (41 FR 25059), and 29 CFR Part 1911, it is hereby proposed to amend Part 1910 of Title 29, Code of Federal Regulations by amending section 1910.1028 as set forth below. In addition, pursuant to section 4(b)(2) of the Act (84 Stat. 1592; 29 U.S.C. 653), OSHA is of the view that the proposed standard is more effective than the corresponding

standards now in Subpart B of Part 1910, in Parts 1915, 1916, 1917, 1918 and 1926 of Title 29, Code of Federal Regulations. Therefore, these corresponding standards would also be superseded by the new proposed standard.

NOTE.—It is hereby certified that the economic and inflationary impact of this proposed regulation has been carefully evaluated in accordance with Executive Orders 11821 and 11949.

Signed at Washington, D.C., this 20th day of May 1977.

EULA BINGHAM,
Assistant Secretary of Labor.

Part 1910 of Title 29 of the Code of Federal Regulations is therefore proposed to be amended by revising § 1910.-1028 to read as follows:

§1910.1028 Benzene.

(a) *Scope and application.* (1) This section applies to production, reaction, release, packaging, repackaging, storage, transportation, handling, or use of benzene.

(2) This section does not apply:

(i) To the storage, transportation, distribution, dispensing, or sale of gasoline as a fuel subsequent to discharge of such gasoline from bulk terminals; or

(ii To work operations where the only exposure to benzene is from liquid mixtures containing 1% (0.1% after one year from the effective date of this standard) or less of benzene by volume, or the vapors released from these liquids.

(b) *Definitions.* For the purpose of this section:

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, or designee.

"Authorized person" means any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area for the purpose of exercising the opportunity to observe monitoring and measuring procedures under paragraph (m) of this section.

"Benzene" (C6H6) (CAS Registry No. 000071432), means benzene, or a mixture of liquids containing benzene, or the benzene vapor released by these liquids, or the benzene vapor released by any other materials.

"Bulk terminal" means a facility which is primarily used for the marketing of gasoline which receives its petroleum products by tanker, barge, or pipeline.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education and Welfare, or designee.

"OSHA Area Office" means that office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the employer's establishment is located.

(c) *Exposure Limits.*—(1) *Permissible exposure limits.* (i) The employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 1 part benzene per million parts of air (1 ppm) as an 8-hour time-weighted average.

(ii) the employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 5 ppm as averaged over any 15 minute period.

(2) *Eye and dermal exposure limit.* The employer shall assure that no employee is exposed to eye contact or repeated skin contact with benzene.

(d) *Regulated areas.* (1) The employer shall establish within the place of employment regulated areas where:

(i) Benzene is produced, reacted, released, packaged, repackaged, handled, stored, or used; and

(ii) Benzene concentrations are in excess of the permissible exposure limit.

(2) The employer shall limit access to regulated areas to authorized persons.

(3) *Notification of Use.* Within 30 days following the establishment of a regulated area, the employer shall report the following information to the OSHA area office:

(i) The address of each establishment which has one or more regulated areas;

(ii) The location of each regulated area;

(iii) A brief description of each process or operation which may result in employee exposure to benzene in each regulated area; and

(iv) The number of employes engaged in each process or operation in each regulated area which may result in exposure to benzene, and an estimate of the frequency and degree of exposure that results.

(e) *Exposure monitoring and measurement*—(1) *Employee exposure.* For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(2) *Monitoring.* Each employer who has a place of employment where benzene is present shall monitor each such workplace and work operation to determine the airborne concentrations of benzene to which employees may be exposed. This determination shall be made by monitoring and measurements which are representative of each employee's exposure to benzene.

(3) *Frequency of monitoring.* The monitoring required under paragraph (e) (2) of this section shall be conducted, and the results obtained, with 30 days of the effective date of this section and thereafter repeated quarterly for employees whose exposure is found not to be in excess of the permissible exposure limit, and monthly for those employees whose exposure is found to be in excess of the permissible exposure limit. Where exposures in excess of the permissible exposure limit, the employer shall continue monthly monitoring until at least two consecutive measurements taken at least (7) days apart are not in excess of the permissible exposure limit, and thereafter the employer shall monitor quarterly.

(4) *Redetermination.* Whenever there has been a production, process, or control change which may result in new or additional exposure to benzene, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to benzene, the employer shall repeat the monitoring which is required by paragraph (e) (2) of this section.

(5) *Employee notification.* (i) Within 5 working days after the receipt of measurement results, the employer shall notify each employee in writing of the exposure measurements which represent that employee's exposure.

(ii) Where the results reveal the employee's exposure to be in excess of the permissible exposure limit, such notification shall also include the corrective action to be taken to reduce exposure to or below the permissible exposure limit.

(6) *Accuracy of measurement.* The employer shall use a method of measurement which has an accuracy, to a confidence level of 95 percent, of not less than plus or minus 25 percent for concentrations of benzene greater than or equal to 1 ppm.

(f) *Methods of compliance.* The employer shall control employee exposures to airborne concentrations of benzene to or below the permissible exposure limit by engineering controls, work practices and respiratory protection as follows:

(1) *Priority of compliance methods.* The employer shall institute engineering and work practice controls to reduce and maintain employee exposures to benzene at or below the permissible exposure limit, except to the extent that the employer establishes that such controls are not feasible. Whenever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (g) of this section.

(2) *Compliance program.* (i) The employer shall establish and implement a written program to reduce exposures to or below the permissible exposure limit solely by means of engineering and work practice controls required by paragraph (f) (1) of this section.

(ii) Written plans for these compliance programs shall include a schedule for development and implementation of the engineering and work practice controls. These plans shall be revised and updated at least every six months to reflect the current status of the programs.

(iii) Written plans for these compliance programs shall be submitted, upon requests, to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, and the employees or their authorized representatives.

(iv) the employer shall institute and maintain the controls described in his most recent written compliance program.

(g) *Respiratory protection*—(1) *General.* Where respiratory protection is required under this section, the employer shall select, provide and assure the use of respirators. Compliance with the permissible exposure limit may not be

achieved by the use of respirators except:

(i) During the time period necessary to install or implement feasible engineering and work practice controls; or

(ii) In work operations such as maintenance and repair activities in which engineering and work practice controls are not feasible; or

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; or

(iv) In emergencies.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select and provide the appropriate respirator from Table I below and shall assure that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those approved by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

TABLE I.—RESPIRATORY PROTECTION FOR BENZENE

Concentration of benzene or condition of use	*Respirator type*
(a) Less than or equal to 10 p/m.	(1) Any chemical cartridge respirator with organic vapor cartridge and; or (2) Any supplied air respirator.
(b) Less than or equal to 50 p/m.	(1) Any chemical cartridge respirator with organic vapor cartridge and full facepiece; or (2) Any supplied air respirator with full facepiece; or (3) Any organic vapor gas mask; or (4) Any self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 1,000 p/m.	(1) Supplied air respirator with half mask in positive pressure mode.
(d) Less than or equal to 2,000 p/m.	(1) Supplied air respirator with full facepiece, helmet, or hood, in positive pressure mode.
(e) Less than or equal to 10,000 p/m.	(1) Supplied air respirator and auxiliary self-contained facepiece in positive pressure mode; or (2) Open circuit self-contained breathing apparatus with full facepiece in positive pressure mode.
(f) Escape	(1) Any organic vapor gas mask; or (2) Any self-contained breathing apparatus with full facepiece.

(3) *Respirator program.* The employer shall institute a respiratory protection program in accordance with § 1910.134 (b), (d), (e) and (f).

(4) *Respirator use.* (i) Where air-purifying respirators are used (cartridge, canister, or gas mask), the employer shall replace the air-purifying canisters or cartridges prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first.

(ii) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is properly fitted.

(iii) The employer shall allow each employee who wears a respirator to wash his or her face and respirator facepiece to prevent skin irritation associated with respirator use.

(h) *Protective clothing and equipment.* Where eye or repeated skin contact with liquid benzene may occur, the employer shall provide and assure that employees wear appropriate protective clothing and equipment to protect the area of the body likely to come in contact with liquid benzene.

(i) *Medical surveillance.*

(1) The employer shall make available a medical surveillance program for all employees who are or will be exposed to benzene. The medical surveillance program shall include:

(i) A history which includes past work exposures to benzene or any other hematologic toxins; a family history of blood dyscrasias including hematological neoplasms; a history of blood dyscrasias including genetically related hemoglobin alterations, bleeding abnormalities, abnormal function of formed blood elements; a history of renal or liver dysfunction; a history of drugs routinely taken, alcoholic intake and systemic infections;

(ii) A complete blood count including red cell count, white cell count, platelet count, hematocrit, hemoglobin, mean corpuscular volume, a differential white blood cell count;

(iii) A reticulocyte count;

(iv) A serum bilirubin; and

(v) Additional tests where, in the opinion of the examining physician, alterations in the components of the blood are related to benzene exposure.

(2) The employer shall assure that all medical procedures are performed by or under the supervision of a licensed physician and provided without cost to the employee.

(3) Medical surveillance and testing of each employee shall be conducted within thirty days of the effective date of this section or within thirty days following placement in a job involving exposure to benzene, and quarterly thereafter.

(4) *Interim examinations.* If the employee is accidentally exposed by ingestion, inhalation or by skin or eye contact under conditions known or suspected to be immediately hazardous, or for any reason develops signs and symptoms commonly associated with toxic exposure to benzene, the employer shall provide appropriate examination and emergency medical treatment.

(5) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its appendixes;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's representative exposure level; and

(iv) A description of any personal protective equipment used or to be used.

(6) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(a) The results of medical testing;

(b) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to benzene;

(c) Any recommended limitations upon the employee's exposure to benzene or upon the use of protective clothing and equipment such as respirators; and

(d) A statement that the employee has been informed by the physician of any medical conditions which require further examination or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(j) *Employee information and training.*—(1) *Training program.* The employer shall provide a training program for employees assigned to workplaces where benzene is present and shall assure that each affected employee is informed of the following:

(i) The information contained in the substance data sheet for benzene which is contained in Appendix A to this part;

(ii) The quantity, location, manner of use, release or storage of benzene and the specific nature of operations which could result in exposure above the permissible exposure limit, as well as necessary protective steps;

(iii) The purpose, proper use, and limitations of respiratory devices as specified in paragraph (g) of this section and in § 1910.134 (b), (d), (e), and (f) of this Part;

(iv) The purpose and a description of the medical surveillance program required by paragraph (i) of this section and the information contained in Appendix C of this section; and

(v) The contents of this standard.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its appendixes readily available to all affected employees.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(k) *Signs and labels.* (1) The employer shall post signs in the regulated area bearing the legend:

DANGER
BENZENE
CANCER HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

(2) The employer shall assure that caution labels are affixed to all containers of benzene and of products containing benzene, and that labels remain affixed when the benzene or products containing benzene are sold, distributed or otherwise leave the employer's workplace.

(3) The caution labels required by paragraph (k)(2) of this section shall be readily visible and legible. The labels shall bear the legend:

CAUTION
CONTAINS BENZENE
CANCER HAZARD

(4) The employer shall assure that no statement which contradicts or detracts from the required information appears on or near any required sign or label.

(l) *Recordkeeping* — (1) *Exposure measurements.* The employer shall establish and maintain an accurate record of all measurements required by paragraph (e) of this section.

(i) This record shall include:

(*a*) The dates, number, duration and results of each of the samples taken, including a decription of the sampling procedure used to determine representative employee exposures;

(*b*) A description of the sampling and analytical methods used;

(*c*) Type of respiratory protective devices worn, if any; and,

(*d*) Name, social security number, and job classification of the employee monitored and all of other employees whose exposure the measurement is intended to represent.

(ii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.

(2) *Medical surveillance.* The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (i) of this section.

(i) This record shall include:

(*a*) A copy of the physician's written opinion; and

(*b*) Any employee medical complaints related to exposure to benzene;

(*c*) A copy of the information provided to the physician as required by paragraph (i)(5) of this section; and

(*d*) A copy of the employee's work history.

(ii) The employer shall maintain medical records required under paragraph (1)(2) of this section for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(3) *Availability.* (i) The employer shall assure that all records required to be maintained by this section be made available upon request to the Assistant Secretary and the Director for examination and copying.

(ii) The employer shall assure that employee exposure measurement records as required by this section be made available for examination and copying to affected employees or their designated representatives.

(iii) The employer shall assure that former employees and the employees' designated representatives have access to such records as will indicate the employees' own exposures to benzene.

(iv) The employer shall assure that employee medical records required to be maintained by this section be made available upon request for examination and copying to a physician designated by the affected employee or former employee.

(4) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (1) of this section.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall transmit these records by registered mail to the Director.

(iii) At the expiration of the retention period for the records required to be maintained under paragraph (1)(1) and (1)(2) of this section, the employer shall transmit these records by registered mail to the Director.

(m) *Observation of monitoring*—(1) *Employee observation.* The employer shall provide affected employees or their designated representatives an opportunity to observe any measuring or monitoring of employee exposure to benzene conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) When observation of the measuring or monitoring of employee exposure to benzene requires entry into an area where the use of protective clothing and equipment, including respirators, is required, the employer shall provide the observer with personal protective clothing or equipment required to be worn by employees working in the area, assure the use of such clothing or equipment, and require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the measurement, observers shall be entitled to:

(*a*) Receive an explanation of the measurement procedures;

(*b*) Observe all steps related to the measurement of airborne concentrations of benzene performed at the place of exposure; and

(*c*) Record the results obtained.

(n) *Effective date.* This section shall become effective 30 days following publication.

(o) *Appendixes.* The information contained in the appendixes is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

APPENDIX A.—SUBSTANCE SAFETY DATA SHEET: BENZENE

I. SUBSTANCE IDENTIFICATION

A. *Substance:* Benzene (C_6H_6).

B. *Permissible Exposure Limit.* 1. *Airborne.* 1 part of benzene vapor per million parts of air (1 ppm) as a time-weighted average (TWA) for an 8-hour workday with a ceiling concentration of 5 ppm, as averaged over any 15 minute period.

2. *Dermal.* Eye contact and repeated skin contact with liquid benzene is prohibited.

C. *Appearance and odor.* Benzene is a clear, colorless liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazard.

II. HEALTH HAZARD DATA

A. *Ways in which the benzene affects your health.* Benzene can affect your health if you inhale it, or if it comes in contact with your skin or eyes. Benzene may also be harmful if you swallow it.

B. *Effects of overexposure.* 1. Short-term (acute) overexposure: If you are overexposed to high concentrations of benzene, you may feel breathless, irritable, euphoric, or giddy; you may experience irritation in eyes, nose, and respiratory tract. You may develop a headache, feel dizzy, nauseous, or experience unsteadiness in walking. Severe exposures may lead to convulsions.

2. Long-term (chronic) exposure: Repeated and prolonged exposure of benzene may cause headache, fatigue, exhaustion, tendency to bleed, nervousness, sleeplessness, shortness of breath, and serious blood disorders, including leukemia.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. Respirators: Respirators are required for those operations in which engineering controls or work practice controls are not available to reduce exposure to the permissible exposure limit. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) seal of approval. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective Clothing: You must wear appropriate protective clothing (such as boots, gloves, sleeves, aprons, etc.) over any parts of your body that could be repeatedly exposed to liquid benzene.

C. Eye and Face Protection: You should wear splash proof safety goggles if it is possible that benzene may get into your eyes. In addition, you should wear a face shield if your face could be splashed with benzene liquid.

IV. EMERGENCY AND FIRST AID PROCEDURES

A. Eye and face exposure: If benzene is splashed in your eyes, wash it out immediately with large amounts of water. Call a doctor as soon as possible.

B. Skin exposure: If benzene is spilled on your clothing or skin, remove the contaminated clothing and wash the exposed skin with large amounts of water and soap immediately.

C. Breathing: If you or any other person breathes in large amounts of benzene, get yourself or the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call a doctor as soon as possible.

D. Swallowing: If benzene has been swallowed do not induce vomiting because it will cause further harm. Call a doctor immediately.

V. MEDICAL REQUIREMENTS

If you are exposed to benzene, your employer is required to provide within thirty days of the effective date of this standard, or within 30 days following placement in a job involving benzene exposure, medical surveillance consisting of a medical history and laboratory tests. These tests shall be provided without cost to you.

VII. OBSERVATION OF MONITORING

Your employer is required to perform measurements that are representative of your exposure to benzene and you are entitled to observe the monitoring procedure. You or your representative are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with, and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to see the records of measurements of your exposure to benzene upon request to your employer. Your medical examination records can be furnished to your physician upon request to your employer. A copy of the physician's written opinion following medical surveillance shall be supplied to you by your employer.

IX. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

Benzene liquid is highly flammable. It should be stored in tightly closed containers in a cool, well ventilated area. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. You should use non-sparking tools when opening or closing benzene containers. You must ground or bond metal benzene containers. Fire extinguishers, where provided, must be readily available and you should know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored. Ask your supervisor where benzene is used in your work area and for additional plant safety rules.

APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES BENZENE

I. PHYSICAL AND CHEMICAL DATA

A. *Substance Identification*. 1. Synonyms: Benzol, benzole, coal naptha, cyclohexatriene, phen, phenyl hydride, pyrobenzol. (Benzin, petroleum benzin, and benzine, do not contain benzene).

2. Formula: C_6H_6 (CAS Registry Number: 000071432).

B. *Physical Data*. 1. Boiling Point (760 mm Hg): 80.1 C (176F).

2. Specific Gravity (water=1): 0.879.

3. Vapor Density (air=1): 2.7.

4. Melting Point: 5.5 C (42F).

5. Vapor Pressure at 20 C (68F): 75 mm Hg.

6. Solubility in Water: .06%.

7. Evaporation Rate (ether=1): 2.8.

8. Appearance and Odor: Clear, colorless liquid with a distinctive sweet ordor.

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. *Fire*. 1. Flash Point (closed cup): −11 C (12F).

2. Autoignition Temperature: 580 C (1076F).

3. Flammable Limits in Air, % by Volume: Lower: 1.3%. Upper: 7.1%.

4. Extinguishing Media: Carbon dioxide, dry chemical, or foam.

5. Special Fire-Fighting Procedures: Do not use solid stream of water, since stream will scatter and spread fire. Water spray can be used to keep fire exposed containers cool.

6. Unusual fire and explosion hazards: Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Where liquid or vapor may be released, such areas shall be considered as hazardous locations. Benzene vapors are heavier than air; thus the vapors may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

7. Benzene is classified as a 1 B flammable liquid for the purpose of conforming to the requirements of 29 CFR 1910.106. A concentration exceeding 3250 ppm is considered a potential fire or explosion hazard. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered Class 1 Group D for the purposes of conforming to the requirement of 29 CFR 1910.309.

B. *Reactivity*. 1. Conditions contributing to instability: Heat.

2. Incompatibility: Heat and oxidizing materials

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide).

III. SPILL AND LEAK PROCEDURES

A. *Steps to be taken if the material is released or spilled*. Large amounts of water should be used to flush the spills. Do not flush benzene into a confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

B. *Waste Disposal Method*. Disposal methods must conform to other jurisdictional regulations. If allowed, benzene may be disposed of: (a) by absorbing it in dry sand or earth and disposing in a sanitary land fill; (b) if small quantities, by removing it to a safe location from buildings or other combustible sources, pouring it in dry sand or earth and cautiously igniting it: (c) if large quantities, by atomizing it in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. Normal Monitoring Program: Measurements taken for the purpose of determining employee exposure are best taken so that the representative average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the 8-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random samples taken on one (1) work shift is an estimate of the employee's average level of exposure for that work shift. NIOSH recommends that samples be collected at a sampling rate of one liter per minute for a minimum of two hours. Air samples should be taken in the employee's breathing zone (air that would nearly represent that inhaled by the employee). Sampling and analysis should be performed by gas absorption tubes with subsequent chemical analysis, by gas chromatography of those areas most likely to represent the highest airborne concentration of benzene where employees are exposed. Methods meeting the prescribed accuracy and precision requirements are available in the "NIOSH Manual of Analytical Methods."

V. MISCELLANEOUS PRECAUTIONS

A. High Exposures to benzene can occur when transferring the liquid from one container to another. Such operations should be well ventilated and good work practices should be established to avoid spills.

B. Non-sparking tools should be used to open benzene containers which should be effectively grounded and bonded prior to opening and pouring.

C. Employers should advise employees of all plant areas and operations where exposure to benzene could occur. A few of the common operations in which high exposures to benzene may be encountered are: manufacture of styrene, phenol, cyclohexane, pesticides, and detergents.

APPENDIX C.—MEDICAL SURVEILLANCE GUIDELINES FOR BENZENE

I. ROUTES OF ENTRY

Inhalation: skin absorption, ingestion.

II. TOXICOLOGY

Benzene is primarily an inhalation hazard. Systemic absorption causes depression of the hematopoietic system. Inhalation of high concentrations can effect the central nervous system function. Aspiration of small amounts of liquid benzene immediately causes pulmonary edema and hemorrhage of pulmonary tissue. Skin absorption through intact skin is possible. Absorption may be accelerated in the case of injured skin, and benzene may be more readily absorbed if it is present in a mixture or as a contaminate in solvents which are readily absorbed. Defatting action of benzene may produce irritation upon repeated or prolonged contact with the skin. High concentrations are irritating to the mucuous membranes of the eyes, nose, and respiratory tract.

III. SIGNS AND SYMPTOMS

Benzene is poorly absorbed through the skin; however, direct contact may cause erythema or blistering. Repeated or prolonged contact may result in drying, scaling, dermatitis, or precipitate development of secondary skin infections. Effects of benzene vapor or liquid on the eye are slight. Only at very high concentrations is there any smarting sensation in the eye. Droplet contamination of the eye by benzene causes a moderate burning sensation, but only a slight transient injury of the epithelial cell, with the eye recovering rapidly. Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation, and or giddiness, followed by a period of depression, drowsiness, fatigue, or vertigo. There may be a sensation of tightness in the chest accompanied by breathlessness and ultimately the victim may lose consciousness. Convulsions and tremors occur frequently, and death may follow from respiratory paralysis or circulatory collapse in a few minutes to several hours following severe exposures. The insidious and often irreversible effect on the blood-forming system of prolonged exposure to small quantities of benzene vapor is of extreme importance. These effects have been noted to occur at concentrations of benzene which may not cause irritation of mucous membranes or any unpleasant sensory effects. Early signs and symptoms of benzene morbidity are varied and vague, and not specific for benzene exposure. Subjective complaints of headache, dizziness, and loss of appetite may precede or follow clinical symptomology. Bleeding from the nose, gums, or mucous membranes and the development of purpuric spots may occur as the condition progresses. Rapid pulse and low blood pressure in addition to a physical appearance of anemia may accompany a subjective complaint of shortness of breath. Clincial evidence of leucopenia and anemia are the most common abnormalities reported, however, macrocytosis and thrombocytopenia are also frequently present. Bone marrow may appear normal, aplastic, hypoplastic or hyperplastic and may not in all situations correlate with peripheral blood findings in-

dicating hypo-hyper-activity of blood forming tissues. There are great variations in the susceptibility to benzene morbidity which prohibits the identification of "typical" blood pictures. The effects of prolonged benzene exposure may appear after several weeks or years after the actual exposure has ceased. Development of leukemia also may result from exposure to benzene.

IV. TREATMENT

Remove from exposure immediately, give oxygen or artificial resuscitation if indicated. Flush eyes and wash contaminated skin. Symptoms of non-specific nervous disturbances may persist following severe exposures.

V. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. Other considerations: Benzene can cause both acute and chronic effects. It is important that the physician become familiar with how exposure to benzene occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. Surveillance and Screening: Medical histories and laboratory examinations are required for each employee subject to exposure to benzene. The employer must screen employees for history of certain medical conditions (listed below) which might place the employee at increased risk from exposure.

1. Liver disease: The primary site of biotransformation and detoxification of benzene is the liver. Liver dysfunctions likely to inhibit the conjugation reactions will tend to promote the toxic actions of benzene. These precautions should be considered before exposing persons with impaired liver function to benzene vapors.

2. Renal disease: Although benzene is not known as a kidney toxin, the importance of the kidney in the elimination of toxic substances and metabolites justifies special consideration in those with possible impairment of renal function.

3. Skin disease: Benzene is a defatting agent and can cause dermatitis on prolonged exposure. Persons with preexisting skin disorders may be more susceptible to the effects of benzene.

4. Blood dyscrasias: Benzene is a hematopoietic depressant. Persons with existing blood disorders may be more susceptible to the effects of benzene.

REFERENCES

(1) Grant W. Morton: Toxicology of the Eye. (Second Edition), Charles C. Thomas, Illinois, 1974, page 655.

(2) Browning, Ethel: Toxicity and Metabolism of Industrial Solvents, Elsevier Publishing Company, Amsterdam, 1965, pp. 440–442.

(3) Patty, F. A.: Industrial Hygiene and Toxicology, Volume II—Toxicology, Interscience Publishers, New York, 1963, pp. 1220–1225.

(4) Gerade, H. W.: Toxicology and Biochemistry of Aromatic Hydrocarbons, Elsevier Publishing Company, Amsterdam, 1960, pp. 98–108.

(Secs. 4, 6, 8, (84 Stat. 1592, 1593, 1599) (29 U.S.C. 653, 655, 657); Secretary of Labor's Order 8–76 (41 FR 25059); 29 CFR Part 1911.)

APPENDIX D

EDITORIAL NOTE.—This appendix consists of a republication of the amendments to 29 CFR Part 1910 that appeared at pages 22516–22529 in the FEDERAL REGISTER of May 3, 1977.

Title 29—Labor

CHAPTER XVII—OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Emergency Temporary Standard for Occupational Exposure to Benzene; Notice of Hearing

AGENCY: Occupational Safety and Health Administration, Labor.

ACTION: Emergency Temporary Standard; Notice of Hearing.

SUMMARY: This emergency temporary standard (ETS) is based on the determination that clinical and epidemiological data conclusively establish that employee exposure to benzene presents a leukemia hazard. Therefore, a grave danger currently exists for workers exposed to this cancer hasard and it is necessary to issue an emergency temporary standard to protect them. By this ETS the Occupational Safety and Health Administration (OSHA) limits employee exposure to benzene to 1 part benzene per million parts of air (1 ppm), as an 8 hour time-weighted average concentration, with a ceiling level of 5 ppm for any 15 minute period during the 8 hour day. In addition, the ETS requires the measurement of employee exposure, engineering controls, personal protective equipment and clothing, employee training, medical surveillance, work practices, and recordkeeping. The ETS will be superseded by a permanent standard within six months. A public hearing on the permanent standard will commence July 12, 1977.

EFFECTIVE DATE: May 21, 1977.

FOR FURTHER INFORMATION CONTACT:

Mr. James Foster, Office of Public Affairs, OSHA, Third Street and Constitution Avenue, N.W., Room N-3641, Washington, D.C. 20210 (202-523-8151).

SUPPLEMENTARY INFORMATION:

APPLICABILITY OF EMERGENCY TEMPORARY STANDARD

The accompanying document is an emergency temporary standard issued pursuant to sections 6(c) and 8(c) of the Occupational Safety and Health Act of 1970 (the Act) (84 Stat. 1596, 1599; 29 U.S.C. 655, 657), the Secretary of Labor's Order No. 8-76 (41 FR 25059) and 29 CFR Part 1911. The new standard, section 1910.1028, applies to all employments in all industries covered by the Act, including "general industry", construction and maritime. For reasons set out below, this standard does not apply to retail automotive service stations or to operations which use liquid mixtures containing 1 percent or less of benzene; however, these exempted operations are still subject to the requirements contained in the benzene standard at 29 CFR 1910.1000.

In addition, pursuant to section 4(b)(2) of the Act, OSHA has determined that this emergency temporary standard is more effective than corresponding standards now applicable to the maritime and construction industries and currently contained in Subpart B of Part 1910, and Parts 1915, 1916, 1917, 1918 and 1926 of Title 29, Code of Federal Regulations. Therefore, those corresponding standards are superseded by the new standard in § 1910.1028.

Pursuant to section 6(c)(3) of the Act, OSHA will shortly commence a rulemaking proceeding under section 6(b) of the Act. The emergency temporary standard will serve as a proposed final rule, along with other proposed requirements which will be published in the FEDERAL REGISTER pursuant to 29 CFR 1911.12. OSHA will publish an additional proposal in the very near future, encompassing those areas of occupational safety and health considered appropriate for the agency's permanent regulation of benzene. This document sets a public hearing on the permanent benzene standard to begin July 12, 1977.

The development of a permanent standard will be conducted pursuant to the rulemaking procedures of section 6(d) of the Act. The Assistant Secretary's decisions on the provisions of the final standard will be based on the entire record developed, including public comments and the informal rulemaking hearing.

EVENTS LEADING TO THE EMERGENCY TEMPORARY STANDARD

Benzene has long been recognized as a toxin affecting the hematopoietic (blood forming) system, and a cause and effect relationship between benzene exposure and observed blood abnormalities has been established for man and animals during the last 75 years. The evidence indicating a relationship between benzene exposure and leukemia has been expanding and the international scientific community has increasingly acknowledged that worker exposure to benzene is associated with an increased risk of leukemia. Data made available by the National Institute for Occupational Safety and Health (NIOSH) in the last few weeks on workers exposed to benzene provide conclusive evidence that benzene is a leukemia causing agent and therefore immediate action to protect workers is imperative. (7)

The present OSHA standard for benzene, found in 29 CFR 1910.1000, Table Z-2, was adopted in 1971 under the authority of section 6(a) of the Act from the American National Standards Institute's (ANSI) Z 37.4-1969 standard. That OSHA standard prescribes an 8-hour time-weighted average of 10 ppm with an acceptable ceiling concentration of 25 ppm. In addition, the present standard allows excursions above the ceiling to a maximum peak concentration not to exceed 50 ppm: *Provided*, That such exposure occurs for no more than 10 minutes in any 8-hour work period. Neither the ANSI standard nor the resultant OSHA standard were based on the possible leukemia hazard from exposure to benzene.

In 1974, Aksoy et al. reported that, when contrasted with the general population, shoe workers having prior exposure to benzene had a significant increased incidence of leukemia.

Also in 1974, pursuant to section 22(d) of the Act, the Director of NIOSH submitted to the Secretary of Labor a criteria document concerning occupational exposure to benzene which stated that "the possibility that benzene can induce leukemia cannot be dismissed."(3) However, NIOSH recommended retention of the present permissible exposure limit of 10 ppm and ceiling concentration of 25 ppm as measured over a 10 minute period which recommendation was not based on benzene's potential leukemia hazard.

In a letter to the Secretary of Labor, dated April 23, 1976, the United Rubber, Cork, Linoleum, and Plastic Workers of America urged that an emergency temporary standard regulating occupational exposure to benzene be issued (42). The request was denied on May 18, 1976 by then Secretary of Labor William J. Usery (43).

Less than 1 year ago, the National Academy of Sciences, under contract with the United States Environmental Protection Agency, reviewed the literature concerning health effects of benzene exposure. (4) The Academy concluded that benzene must be considered as a suspect leukemogen.

In August 1976, NIOSH submitted to OSHA an updated criteria document which revised its earlier assessment of 1974. (5) On the basis of a review of old studies and new data, NIOSH concluded that benezene was leukemogenic. This report further pointed out that "it is apparent from the literature that benzene leukemia continues to be reported." NIOSH, therefore, recommended that, since no safe level for benzene exposure could be established "no worker be exposed to benzene in excess of 1 ppm in air". Following publication of the updated criteria document, the Director of NIOSH recommended to the Assistant Secretary of Labor, by letter dated October 27, 1976, that OSHA publish an emergency temporary standard for benzene establishing the exposure level at 1 ppm. (6) Based on the information supplied by NIOSH, OSHA issued on January 4, 1977 voluntary "Guidelines for Control of Occupational Exposure to Benzene," recommending that exposure to benzene in air not exceed an 8-hour time-weighted average of 1 ppm in any 8-hour shift of a 40 hour week. (44)

In January 1977, NIOSH informed OSHA that workplace environments had been found in St. Mary's and Akron, Ohio where a sufficient number of employees had been exposed to benzene for a number of years to facilitate an epidemiological study of health risks. (45) The worksite was a Pliofilm manufacturing plant owned by Goodyear Tire and Rubber Company. The preliminary conclusions of the epidemiological study NIOSH conducted of the pliofilm workers were transmitted to OSHA on April 15, 1977. (7) The NIOSH data demonstrated an incidence of leukemia in workers exposed to benzene that was at least five times the expected incidence. NIOSH concluded that:

...e report shows a statistically significant ... in the risk for developing myelogenous leukemia among workers exposed to benzene. We hope this new information will be of assistance to you in reaching a decision on the most appropriate regulatory action.

In his letter of April 15, 1977, transmitting the report on the Goodyear Pliofilm plant, the Director of NIOSH again urged that an emergency standard be issued.

REASONS FOR ISSUANCE OF AN EMERGENCY TEMPORARY STANDARD

The Assistant Secretary finds that exposure to benzene poses a grave danger to humans. Specifically, human exposure to benzene can induce chromosomal aberrations, bone marrow damage and destruction, and other blood dyscrasias. Moreover, the accumulated studies strongly support the conclusion that benzene causes leukemia in humans. The data collected by NIOSH and made available during the past few weeks show that workers exposed to benzene in an Ohio Pliofilm plant have contracted leukemia at a rate at least five times the rate expected in the general population. Because of the conservative statistical approach to evaluating these preliminary data, final results of this study will certainly show that the increased risk of developing leukemia from exposure to benzene is even greater than five times the normal incidence of this disease. This new evidence has been interpreted by NIOSH, and is found by OSHA, to conclusively establish that benzene causes leukemia in humans. This conclusion is supported by the substantial body of clinical and epidemiological evidence previously vail-epidemiological evidence previously available which suggested the same casual relationship between benzene exposure and leukemia. In view of the new evidence the relationship can no longer be subject to serious question.

The Assistant Secretary concludes, based on a review of the latest NIOSH study and recommendations together with the epidemiological and clinical studies and other scientific data, that benzene exposure subjects workers to the risk of contracting leukemia, a malignant and irreversible disease. The best available scientific evidence indicates that no safe level for exposure to a carcinogen, including benzene, can be established or assumed to exist. OSHA has considered this question of a safe level in previous rulemaking proceedings (see preambles to carcinogen standards (39 FR 3758), vinyl chloride standard (39 FR 35892), and coke oven emissions standard (41 FR 46742)) and has relied on that considerable body of scientific opinion holding that, when dealing with a carcinogen, no safe level exists for any given population. For example, the National Cancer Institute's Ad Hoc Committee on the Evaluation of Low Levels of Environmental Chemical Carcinogens (1976) states:

No level of exposure to a chemical carcinogen should be considered toxicologically insignificant for man. For carcinogenic agents, a "safe level for man" cannot be established by application of our present knowledge. (NCI, 1976, p. 1)

And NIOSH has taken the position that in regulating cancer-causing substances "• • • it is not possible at present to determine a safe exposure level for carcinogens." (Rev. Arsenic Crit. Doc. 1975.)

Since leukemia is a form of cancer and exposures generally below 25 ppm have already induced leukemia, it is not currently possible to determine whether a safe level of exposure exists for worker populations exposed to benzene. Therefore, the Assistant Secretary has determined that exposure must be reduced to the lowest feasible level.

Furthermore, during the period of time for normal rulemaking, workers would continue to be exposed to levels higher than those that may be achieved by this ETS.

In conclusion, the Assistant Secretary determines that exposure of employees to a cancer-causing substance in the workplace environment is a "grave danger" within the meaning of section 6(c)(1)(A) of the Act. The proposition that cancer, and substances that cause cancer, pose a grave danger to man does not need lengthy discussion. The nature of a cancer hazard differs from other types of toxicity. Employees exposed to carcinogens risk incurable, irreversible and, in most cases, fatal consequences. These consequences may be irreversibly set in time. No symptomatic evidence of the development of the cancer may be apparent to the employee during a long latency period. A single exposure episode may be sufficient to cause cancer. These factors, which establish the grave danger posed by exposure to carcinogens, also lead inexorably to the conclusion that it is necessary to provide immediate protection for employees through the issuance of an emergency temporary standard, within the meaning of section 6(c)(1)(B) of the Act.

The existing 10 ppm standard, adopted from the ANSI national consensus standard, was based largely on benzene's general toxicity rather than on the leukemia hazard and, therefore, does not, within the meaning of section 6(b)(8) of the Act, provide the protection now shown to be necessary. The Assistant Secretary finds that this emergency temporary standard better effectuates the purposes of the Act than the National consensus standard.

BACKGROUND AND DISCUSSION OF EARLIER DATA

Benzene (C_6H_6) is a clear, colorless, non-corrosive, highly flammable liquid with a strong, rather pleasant odor. Benzene's low boiling point and high vapor pressure cause it to evaporate rapidly under ordinary atmospheric conditions, giving off vapors nearly three times heavier than air.

Benzene is produced primarily by the petrochemical and petroleum refining industries by the process called catalytic reformation, which converts certain lower octane hydrocarbons into higher octane aromatics. The two industries are responsible for 94 percent of the total U.S. production of benzene. Recovery through catalytic reformation, including the benzene formed from the hydrodealkylation of toluene, accounts for almost 90 percent of the total quantity produced. Recovery of coal-derived benzene, primarily as a by-product of the coking process in steel mills, was once the major source of benzene. Today, however, it accounts for only 6 percent of the total U.S. production.

The production of benzene is rapidly expanding with approximately 11 billion pounds produced in 1976. Only eleven other chemicals and only one other hydrocarbon (ethylene) are produced in greater tonnage in the U.S. Approximately 86 percent of this benzene is used chiefly as an intermediate in the production of other organic chemicals, including styrene, phenol, and cyclohexane. The remaining amount is used primarily in the manufacture of detergents, pesticides, solvents and paint removers. Benzene is also present as a component of motor fuels, averaging less than 2 percent in gasoline.

The first major industrial use of benzene, however, was as a solvent in the rubber industry just preceding World War I. During World War I, benzene production was stimulated greatly by the demand for and resulting production of toluene in the manufacture of explosives. The large quantities of benzene which were produced resulted in its more widespread use as a starting point for the manufacture of various organic compounds. This situation led to greatly increased uses of benzene as a solvent in the artificial leather, rubber goods, and rotogravure industries, and as a starting material in organic synthesis.

Industries and processes currently using benzene include the chemical, printing, lithograph, rubber cements, rubber fabricating, paint, varnish, stain removers, adhesives, and petroleum industries. Benzene is also used extensively in chemical laboratories as a solvent and as a reactant in numerous chemical applications. Where benzene is produced and used in large amounts, it is generally used in enclosed systems, although exposures can occur during liquid transfer operations, from equipment leakage and carryover losses, and in maintenance operations.

A. *Toxic effects.* Benzene has been recognized as a toxic substance capable of causing acute or chronic effects since 1900. Inhalation is the primary route of entry of benzene in the worker. Benzene diffuses rapidly through the lungs and is quickly absorbed into the blood. The rate of absorption is greatest during the first five minutes and thereafter declines significantly. Benzene saturation of the circulating blood may reach as high as 70–80 percent of the air content of benzene within the first 30 minutes. Relatively complete saturation of the blood may not be attained for two to three days.

Though the available literature suggests that benzene is not readily absorbed through the human skin, appreciable

quantities of benzene could be absorbed in the case of injured skin. Moreover, absorption of benzene by the skin may be significantly accelerated when benzene is present in a mixture or as a contaminant in solvents known to be readily absorbed, such as toluene and xylene. (48)

The benzene absorbed by the circulating blood is distributed throughout the body where, because of its liposolubility, it tends to accumulate in various body organs in proportion to their fat content.

Upon removal from benzene exposure, the concentration of benzene in the expired breath follows an exponential decay curve, reflecting removal of benzene from various body compartments. Elimination via this route has been estimated to range from 12 to 50 percent of the total amount of benzene absorbed in humans.

A fraction of the absorbed benzene is eliminated in an unchanged form, primarily in the expired air and, to a minimal extent, in the urine. The remainder of the absorbed benzene is metabolized by enzymes contained in the liver and ultimately to derivatives which are more water soluble thereby facilitating their removal by the kidneys. A first intermediate in the biotransformation of benzene is believed to be benzene epoxide, a highly reactive intermediate and one of several candidates suggested as the active agent responsible for benzene's myelotoxic effects. Phenol, and to a lesser extent, hydroquinone, pyrcatechol, and phenyl-mercapturic acid are the primary metabolites of benzene found in urine.

B. *Acute effects.* Exposures to high concentrations of benzene produce an almost immediate effect upon the central nervous system. Benzene concentrations of about 20,000 ppm are fatal within minutes, with death occurring from acute circulatory failure or coma, with or without convulsions. Milder exposures produce a period of nervous excitation, euphoria, headache and nausea, followed by a period of depression which can result in cardiovascular collapse and/or unconsciousness. The occurrence of nonspecific nervous disturbance as an aftereffect of acute exposures is dependent on duration of unconsciousness and/or severity of circulatory failure. Breathlessness, nervous irritability, and unsteadiness in walking have been observed to persist for a period of several weeks. Inhalation of still lower concentrations (250–500 ppm) yields signs and symptoms of mild poisoning, characterized by vertigo, drowsiness, headache, and nausea. Rapid recovery from these symptoms usually occurs following cessation of exposure.

Direct contact with the liquid may cause erythema and blistering. Prolonged or repeated skin contact, even with small quantities of benzene, has been associated with the development of a dry, scaly dermatitis or with secondary infections.

C. *Chronic effects.* Benzene exerts a primary toxic effect in the bone marrow, the major blood forming organ. Long-term exposures to low concentrations of benzene have been observed to have an initial stimulatory effect on the blood-forming tissue (bone marrow) followed by aplasia (no cell production) and fatty degeneration. Clinically an initial increase, then decrease, in the red blood cells, white blood cells, or platelets, is seen, with progression if exposures are continued, to aplastic anemia (lack of functioning of bone marrow), leucopenia (decrease in leucocytes which are white blood cells), thrombocytopenia (decrease in platelets), or pancytopenia (decrease in all cells in the peripheral blood). Secondary effects of thrombocytopenia include coagulation disturbances, characterized by increased bleeding time, poor clot retraction, and increased susceptibility to hemorrhaging. This clinical picture of chronic benzene poisoning may exist with or without the physical signs or symptoms of fatigue, vertigo, headache or excessive bleeding.

The following studies are representative, although by no means all inclusive, of the published literature on the chronic effects in humans of benzene exposure. These studies do however illustrate the diversity and variability of effects which dominate the literature on chronic benzene exposure.

1. *Blood dyscrasias.* Greenburg and coworkers' investigation in 1939 of 332 pressmen in three rotogravure printing plants was one of the earliest, comprehensive studies of benzene poisoning.(8) In addition to physical examinations, including medical and occupational histories and laboratory tests, workplace air samples and chemical analysis of ink solvents and thinners were performed in an attempt to provide a correlation with medical findings. Air samples (48) revealed benzene concentrations ranging from 11 ppm to 1060 ppm for 3 plants.

Five workers with the most severe benzene poisoning expressed no subjective complaints and physical examination revealed negative findings. The signs of "poisoning" included a reduction in the number of erythrocytes, leucocytes and platelets.

Greenburg stated that: "These findings illustrate the well-known fact that the effects of benzene may be persistent and also suggest that even before blood changes are apparent, processes may have been initiated that will continue to develop even after exposure to benzene has ceased." The authors also reported that individuals varied greatly in susceptibility although data on personal monitoring were not available.

In the same year, Mallory et al. reported post-mortem findings in 19 case studies of workers with a history of chronic exposure to benzene.(9) Exposures varied from 6 months to 12 years, but no exposure levels were available. The authors indicated that significant changes were found regularly throughout the entire hematopoietic system including bone marrow, liver, spleen and lymph nodes. Of the 19 case studies, six exhibited hypoplasia of the bone marrow (decreased bone marrow function), whereas nine cases showed hyperplasia (overactivity of the bone marrow), and two were diagnosed as leukemia. The authors concluded that exposure to benzene under varying conditions produced diverse reactions and that individual variation was of great importance.

In 1949, Hardy and Elkins investigated an artificial leather plant in Massachusetts in which a man who had been employed as a coating machine operator for 12 years died of what was diagnosed as benzene poisoning.(10) The subject had worked as a coating machine operator in other locations for 18 years. Fifty-two workers were still employed in the leather plant. Benzene concentrations ranged from 40 to 80 ppm with an average concentration of 60 ppm. Blood studies, performed upon all 52 employees, showed abnormalities in more than one blood component in sixteen of the employees. Abnormalities were observed in hemoglobin, RBC, and WBC counts. There was a wide variation among subjects as to the particular component affected. Six of the 16 employees with blood abnormalities worked in the same coating room as the deceased man. Despite this evidence of blood abnormalities from the laboratory tests, none of the physical examinations revealed any clinical signs or symptoms of overexposure to benzene.

In an epidemiological investigation, Aksoy et al compared the hematological findings of 100 healthy male subjects (controls) with those of 217 apparently healthy males, 95 percent of whom worked with solvents containing benzene in small shoe shops. (11) The shops were considered unhygienic and poorly ventilated. The concentration of benzene in the working environment ranged from 15 to 30 ppm during non-working hours to 210 ppm when adhesives containing benzene were being used. The duration of employee exposures ranged from 3 months to 17 years. In 51 (23.5 percent) of the 217 employees, hematological abnormalities were found consisting of leucopenia (9.7 percent), thrombocytopenia (1.84 percent), leucopenia associated with thromobocytopenia (4.6 percent) and pancytopenia (2.7 percent). In addition, relative to controls, benzene-exposed workers demonstrated a significant reduction in mean white cell counts and mean platelet counts. The proportion of benzene-exposed workers diagnosed with anemia was increased when compared to controls; however the presence of iron-deficiency anemia could not be ruled out.

In French survey of 45 fatal cases of benzene induced diseases of the blood, covering the years 1947 to 1962, 23 were diagnosed as leukemia and 22 were attributed to aplastic anemia. Of the latter cases, one patient was afflicted after only 2 years exposure to benzene with the remainder having an average exposure of 16 years. (12) The authors also reported that in the cases of aplastic anemia, the evolution of the illness was lengthy. A similar observation was also reported by Vigliani and Forni (1969). (14) Of 32 fatal cases of chronic benzene poisoning seen in the provinces of Milan and Pavia, 18 were due to leukemia and 14 due to aplastic anemia. These authors noted that

aplastic anemia usually occurs in patients while they are still being exposed to high concentrations of benzene. In a later study, Vigliani reported that among 59 surviving workers with benzene-related aplastic anemia, 11 later died from acute leukemia. The author also reported that he had knowledge of at least 150 cases of leukemia attributed to benzene in Italy alone. (49)

Pancytopenia has been equated with aplastic anemia, although strictly defined aplastic anemia is characterized by pancytopenia and accompanied by a fatty displacement of the bone marrow. In 1976, Vigliani and Forni stated:

> In the past two decades, the case records of patients with acute or subacute leukemia, usualy with leukopenia at some state of the illness, have become so numerous that they exceed those of acute pancytopenia. This finding led us to suspect that many cases that were considered as acute pancytopenia in the past, prior to the introduction of bone marrow biopsy, may in fact have been examples of acute hemocytoblastic leukemia leucopenic and aleukemic, or with few microhemocytoblasts in the circulating blood, possibly mistaken for lymphocytes. (15)

Unsuccessful at inducing chronic poisoning through inhalation of vapors, Sellings in 1916 produced leukopenia in rabbits through subcutaneous injections of commercially pure benzol with olive oil. (12) Selling's findings demonstrated a constant, well defined aplasia of the bone marrow, characterized by the complete disappearance of leukocytes in the peripheral blood. He noted that although both the myeloid and lymphoid tissues are vulnerable, that myeloid tissue is injured to a greater extent.

Deichman et al (1963) published results of animal studies which also indicated the great toxicity of benzene vapors for hematopoietic tissue. (16) Eight groups of rats, consisting of 40 animals per group, were exposed to benzene vapors at average concentrations of 831, 65, 61, 47, 44, 31, 29, and 15 ppm respectively. The duration of exposure was for 5 hours per day, 4 days per week, for periods ranging from 5 weeks to 7 months. Exposures to the three highest concentrations resulted in a significant leukopenia after 14 weeks. A moderate, but definite, leukopenia occurred in the rats exposed to 47 and 44 ppm after 5 to 8 weeks of exposure. Exposures to three lowest benzene concentrations for periods of 4, 3, and 7 months, respectively, induced no demonstrable changes in the numbers of leucoytes.

2. *Chromosomal aberrations.* The development of various chromosomal aberrations in peripheral leukocytes and bone marrow cells has also been attributed to benzene exposures. Several investigators characterized these aberrations as both unstable chromosome changes (i.e. including fragments, dicentric, tricentric and ring chromosomes) or stable chromosomal changes (i.e. deletions, translocations, inversions, and trisomies). These types of chromosomal aberrations also occur as the result of exposure to ionizing radiation, which is known to induce leukemia.

Increases in chromosomal aberrations in subjects suffering from benzene hemopathy were investigated by Pollini and Colombi and by Forni and Moreó. (17), (18), (19)

Forni et. al. examined chromosomal changes and their evolution in 25 individuals who had suffered bone marrow impairment of varying severity, 1–18 years previously, as a result of exposure to benzene. (20) Hematologic examinations performed at the time of the cytogenetic study, but subsequent to cessation of exposure and recovery from benzene hemopathy, indicated normal blood values. However, both stable and unstable chromosomal changes were still present. The authors noted that "This finding (persistence of chromosomal aberrations) is similar to that reported in individuals with past exposure to ionizing radiations, both therapeutic and accidental, and suggests that long-lived lymphocytes might maintain chromosome damage even for years".

Chromosomal changes in individuals either no longer exposed to benzene, or exposed intermittently to low levels, and who show no hemotological disorders, have also been investigated. After examination of three groups of factory employees who displayed no toxic symptoms, Tough et al reported that two of these groups exposed on the average of 8 and 15 years, respectively, to similar working environments containing between 25 to 150 ppm benzene, showed a significant increase of structural chromosomal aberrations in lymphocytes over the general population. (21) The third group of workers from a different kind of factory and exposed to approximately 12 ppm for an average of 13 years showed a frequency of chromosome aberrations not significantly different from those found in the general population. Tough et al suggested that their findings may indicate that an interplay between the age of workers and exposure to benzene is responsible for the observed effects.

Induction of chromosomal damage in rabbit lymphocytes by subcutaneous injection of benzene has been reported by Kissling and Speck. (22) During the phase of peripheral pancytopenia the frequency of mitotic figures showing aberrations (mostly gaps and breaks) increased from an initial value of 6 percent to 58 percent after an average of 18 weeks. Two months later, after the discontinuance of benzene treatment, visible chromosomal damage was still observed in 36 percent of the mitotic cells. Also Philip and Jensen in a preliminary report demonstrated that a single subcutaneous injection of benzene (dose: 2.0 ml benzene/kg body weight) administered to rats is capable of increasing the fraction of marrow cells which exhibit chromosomal abnormalities.(23)

3. *Leukemia.* As pointed out, benzene presents a considerable range of health risks to the working population. These include the threat of developing a form of cancer known as leukemia, a fatal and irreversible disease. Robbins defines leukemia by stating:

> Leukemia may best be considered as a neoplasm (cancer) of the white blood cells and is so classified in the "International Lists of Causes of Death." It is characterized chiefly by: the appearance of abnormal, immature white cells in the circulating blood; diffuse and almost total replacement of the bone marrow with the leukemic cells; and widespread infiltrates of the liver, spleen and other tissues, analogous to metastatic dissemination of solid tissue cancer. (24)

The recent epidemiological study of Infante et al., (51) demonstrating a five-fold increased risk of total leukemia and a ten-fold increased risk of mylomonocytic leukemia among Pliofilm workers exposed to benzene, is supported by numerous case reports in the scientific and medical literature over the past several years concerning benzene related leukemia, predominantly of the mylogenous type.

At the outset it should be noted that, prior to the development of the Infante et al. data conclusively showing the linkage between benzene exposure and the development of fatal leukemia in workers, many had argued that any substance capable of inducing bone marrow depression or other blood abnormalities should be treated as a potential leukemogen. For example, Cronkite stated over twenty years ago that:

> The heart of the problem in the induction of leukemia by industrial hazards rests upon quantitation of the agent and the yield of leukemia. Two agents used in industry have been correlated with an increased incidence of leukemia in human beings. The first, ionizing radiation, is unquestionably able to increase the incidence of leukemia. The second agent, bensol, probably can produce an increased incidence of leukemia, but the data are not as good as for the former. First, the finger of suspicion must be pointed at any agent which is able to produce an aplasia of the bone marrow, assuming it will probably be able to produce leukemia also. Second, there is no reason to doubt that any agent which will produce a cancer elsewhere in the body will not be able to produce leukemia if the offending agent is transported to the hemopoietic tissues. (25)

And, as the National Academy of Sciences pointed out in its report of June 1976:

> Benzene fits in the former category because it is well documented that it produces aplasia of the bone marrow.(4)

And as Williams et al. notes:

> Any chemical capable of producing myelotoxicity must be regarded as a potential leukemogen, if the findings in radiation—induced leukemia apply which indicate that cell damage with depression of marrow function may produce alterations leading to the transformation of damaged cells into neoplastic ones. The only chemical which has been clearly identified as one which increases the incidence of myeloid leukemias in man is benzene in rather heavy occupational exposure.(26)

The relationship between benzene exposure and leukemia in humans in the past has resulted in large part from clinical observation and to a lesser degree from epidemiological studies. The clinical evidence of leukemia has been obtained either from a survey of medical records primarily in various European

clinics, or from a canvass of the published literature reporting case histories of individuals diagnosed with leukemia. In lieu of quantitative, individual exposure data, subjective evaluations of intensity of exposure have been utilized. The epidemiological evidence has been derived from either the determination of the frequency of chronic benzene exposure among cases of leukemia or from the determination of frequency of, or mortality from, leukemia among employees of work shops that utilize benzene. In other words, in the first method the leukemia is the constant factor of all case studies and the benzene exposure is the variable; while the second method is the reverse, that is, the benzene exposure is the constant factor while leukemia is the variable.

Vigliani and Saita, in their review of 47 individuals suffering from benzene hemopathy between the period of 1942 and 1963, presented clinical and laboratory accounts of six cases, all of whom were diagnosed as having haemocytoblastic leukemia. (27) The period of exposures of these individuals to either resins, inks, varnishes, or glues containing varying concentrations of benzene ranged up to 19 years. Data on the concentrations of benzene in the workplace environment, with one exception (190–660 ppm) were not available. Although information on previous occupational histories or medical status prior to the final diagnoses were also not available, the authors stated that "attribution of the cases (of leukemia cited) to the exposure cannot be doubted." During the years 1962–1963, when there was sharp rise in the incidence of leukemia among workers exposed to benzene which coincided with an increase in number of benzene poisoning cases for this period, the risk of acute leukemia was estimated to be about 20 times greater than the risk for the general adult population.

Twelve years following the Vigliani and Saita study, Vigliani and Forni observed that in the rotogravure industry, no new cases of aplastic anemia nor of leukemia were found among workers exposed solely to toluene after this solvent was substituted for benzene in 1964. (15) However, these authors noted in 1974 that cases of benzene-induced leukemia with long latency periods may still be occasionally observed. (50) These investigators also observed that workers exposed to toluene did not exhibit chromosomal aberrations, a finding seen in employees who work with benzene.

Sixteen (16) cases of various forms of leukemia developing from long term exposure to benzene were reported by Tareef et al. (28) The duration of exposure ranged between 4 and 27 years. However, no exposure concentrations were reported. In contrast to data previously reported in Italy and Turkey, the authors found evidence of chronic leukemia. Acute leukemia accounted for only 6 of the 16 cases. Three of the six acute leukemias were diagnosed at 2, 4 and 5 years following cessation of benzene exposure. Four of the acute cases underwent a definite period of hematologic shifts ranging from anemia or leucopenia to aplastic anemia and spanning a period of 2 to 10 years. Of the 10 chronic cases reported, none of the patients had hemocytopenic changes prior to the onset of leukemia.

Aksoy et al. reported the deaths, due to leukemia, of four Turkish shoemakers resulting from their exposure to benzene for periods ranging from 6 to 14 years. (29) At the time of the study, air concentrations were found to be between 150–210 ppm of benzene. Previous occupational exposure data was not provided. Two of the four patients developed acute leukemia approximately two and three years after the occurrence of aplastic anemia although the other two did not.

Adding 8 new cases of leukemia associated with exposure to benzene to 26 previously found, between the years 1967 and 1973, Aksoy et al. observed that with the exception of one case of chronic myeloid leukemia, all had various forms of acute leukemia. (30) A preceding period of pancytopenia was reported present in almost 25 percent of the cases, and the interval between the pancytopenic period and the onset of leukemia varied from 6 months to 6 years. Often the clinical findings and blood picture improved considerably before leukemia was diagnosed. During an 8 year period of observation, the incidence of leukemia among shoe-workers chronically exposed to benzene was calculated to be more than twice that experienced by the general population (13.5/100,000 vs. 6/100,000).

Browning tabulated from published studies 61 cases of leukemia among workers exposed to benzene at various concentrations. (31) The majority of cases were of the myeloid series. Browning noted that "benezene leukemia is frequently superimposed on a condition of aplastic anemia, but can develop without a preceding peripheral blood picture characteristic of bone marrow aplasia." She also noted that the transition from aplastic anemia to leukemia was not unknown in the ideopathic forms of leukemias.

DeGowin (32) and others (Vigliani & Saita, Tareff, Aksoy etc.) observed that the development of acute leukemia in some individual cases was preceded by a latency period of up to 15 years following cessation of exposure to benzene. Some of the cases underwent what was considered to be a preleukemic period, which was characterized by leucopenia, anemia, thrombocytopenia, aplastic anemia, pancytopenia or a combination thereof. Other cases developed leukemia without any evidence of anemia. According to Vigliani and Saita, the time delay "does not permit us to attribute the disease to the persistence of benzene in the bone marrow". (27) They suggested, however, that "on the basis of the initiation-promotion theory of the induction of neoplasms, we might regard benzene as an initiator of the leukemia process, but we have no suggestion of a possible promoter."

Based on the hypothesis that the risk of leukemia was higher among workers who were exposed to benzene and medical x-rays, Ishimaru et al. conducted a retrospective epidemiological investigation examining the relationship between occupations and environmental factors, other than A-bomb exposure, and the incidence of leukemia in Nagasaki and Hiroshima between 1945 and 1967. (33) This case control study compared all cases diagnosed as definite or probable leukemias between 1945 and 1967 and residing, at the time of the onset of the disease, in Hiroshima or Nagasaki. Controls were matched for city, sex, date of birth (±30 months), distance from the atomic bomb explosion, and alive and residing in either city at the time of the onset of the disease in the patient. Four hundred ninety-two leukemia cases were identified, but matched controls could only be obtained for 413. Fifteen occupations were selected in which there had been exposure to either medical x-rays or solvents especially benzene and its derivatives. Three hundred and three adult cases with the onset of leukemia at age 15 years or over and their controls were compared. Eleven of the 15 occupations were selected based on whether there had been a history of such occupations by either the leukemia cases or the controls. Considered as a group, the risk of leukemia was found to be significantly higher (about 2.5 times greater) among those with a history of such occupations in which various volatile solvents were used as compared with those without. The relative risk was 1.8 times higher for chronic leukemia and 2.9 times higher for acute. Eighteen of the leukemia cases associated with solvents were located in distant and non-exposed radiation areas and were considered too far from the A-bomb explosion for radiation to have enhanced the increased risk. Accepting the source of error inherent in the method which was used to collect the data, the results of this study nonetheless reinforce the observation that an increase in leukemia existed in that portion of the population exposed to radiation and employed in an occupation where solvents were used, especially benzene or where exposure to medical x-ray occurred.

Thorpe, then Associate Medical Director for the Exxon Corporation, on the other hand, reported that the incidence of leukemia among a population of 38,000 workers exposed to low levels of benzene over a ten year period (1962–1972) was not significantly different when compared with the general population. (34)

This study has been severely criticized by Brown for its relaxed case-finding techniques and the methods of analyses. (35) Thus, the conclusions derived from this study must be viewed in the light of serious methodological problems which were encountered in the collection and treatment of the data. These problems, which were also acknowledged by Thorpe, included: (1) the low incidence of leukemia in the general population; (2) the validity of the diagnosis of leukemia, (3) the quantitative determina-

tions of the extent of exposures, (4) an inadequate follow-up of annuitants and (5) incomplete occupational histories on individuals diagnosed as having leukemia.

Infante et al. recently reported the results of an ongoing epidemiologic study among workers exposed to benzene during the manufacture of Pliofilm, a process unconfounded with mixed solvent exposures. (51) Although follow-up is less than 75% completed, the results already demonstrate a statistically significant excess of leukemia in benzene exposed workers as compared with the expectations based on the U.S. white male population or on a second population employed at an industry in the same state over the same period of time. Among benzene exposed workers, a five-fold excess of total leukemia and a 10-fold excess of myelomonocytic leukemias were demonstrated even under conditions leading to an underestimate of the true leukemia risk. Those conditions were the treatment and the analyses of individuals whose vital status was unknown—they were assumed to be alive until the last day of the study period. Note was made of the consistency of the types of leukemia in this study population (myelogenous and monocytic) with earlier case reports by Vigliani of workers who had died from benzene related leukemia in Italy.

The wide variety of clinical manifestations and hematological disorders observed in humans exposed to benzene, which range from simple anemia and leukopenia to aplastic anemia have been experimentally induced in animals. However, attempts to demonstrate the development of leukemia in animals exposed to benzene has met with less success. To date, a study by Lignac in 1932 is the only animal study known to OSHA in which leukemia has been observed in animals exposed to benzene. (38) Fifty-four mice (28 females, 26 males) were given subcutaneous injections of benzene (0.001 ml in 0.1 ml of olive oil) for 17 to 21 weeks. Nine mice were initially excluded following bacteriological examination and an additional 12 were lost through atrophy of various organs, especially the spleen. Lignac attributed these deaths to the size of the dose of benzene based upon the findings of a preceding experiment. Eight of the remaining 44 mice developed leukemia or Kundrat's lymphosarcoma and died 4 to 11 months after receiving the first injection. The absence of concurrent controls makes interpretation of the results difficult, and uncertainties as to the strain of the mice studied has frustrated efforts to independently confirm the findings.

More recent studies have failed to produce Lignac's results. Amiel in 1960 utilized four inbred strains of mice and subjected them to the same experimental program outlined in Lignac's study. (39) No leukemic or aplastic hemopathies were observed. More recently, Ward et al. administered benzene subcutaneously to a species and strain of mice which is responsive to leukemogenic agents. (40) Although they observed a slight increase in the percentage of granulocytic leukemias in the benzene-treated mice as compared with the controls, the authors viewed the increase as not statistically significant.

SUMMARY AND EXPLANATION OF THE STANDARD

The requirements of the emergency temporary standard are those which OSHA considers essential and feasible to protect employees from the grave danger resulting from benzene exposure until a permanent standard can be promulgated in accordance with sections 6 (b) and (c) of the Act. The following section discusses the significant provisions of the emergency temporary standard for benzene and the necessity for including these provisions in the ETS.

A. *Scope and application.* The emergency temporary standard applies to all employers and all establishments in which benzene is present, except for two general groups. The ETS does not apply to retail automotive service stations. It's estimated that there are presently more than 200,000 such service stations in the country. Further, the limited evidence presently available suggests that employee exposures during gas dispensing operations are generally below 1 ppm. In light of these facts, and the relatively short duration of the ETS, it has been determined that exclusion of such service stations from the ETS would be appropriate.

Similarly, the ETS does not cover exposure to liquids containing benzene in amounts of 1 percent or less by volume, or benzene vapor released by these liquids. Benzene is a contaminant as well as an additive in a multitude of industrial substances. OSHA estimates that some 60,000 facilities with over 400,000 employees are engaged in industrial operations utilizing liquid mixtures containing 1 percent or less benzene by volume.

Also based on the presently available evidence in the Arthur D. Little study the exposure of employee working with these mixture is generally less than 1 ppm on an 8 hour average. In view of the foregoing, the ETS excludes users of these mixtures from its coverage.

However, during the proceedings on the proposed permanent standard, it is OSHA's intention to consider the appropriate scope and application of its permanent standards to protect workers from the leukemia hazard of benzene exposure.

Meanwhile, the existing standard in § 1910.1000 which governs benzene exposure will continue to apply to retail automotive service stations and to operations which use liquids containing one percent or less benzene.

Thus, these employers must continue to limit their employees' exposures to benzene to the 10 ppm permissible exposure limit, 25 ppm limit ceiling and 50 ppm excursion limit of that section.

The emergency temporary standard is applicable to "general industry," construction and maritime.

B. *Permissible exposure limit.* The standard has separate permissible limits for airborne exposure and for eye and dermal exposures.

(1) *Airborne exposure limits.* Considerable scientific opinion supports the regulatory policy for carcinogens that no safe level exists for any exposed population. For example, the National Cancer Institute's Ad Hoc Committee on the Evaluation of Low Levels of Environmental Chemical Carcinogens (1970) stated:

> No level of exposure to a chemical carcinogen should be considered toxicologically insignificant for man. For carcinogenic agents, a "safe level for man" cannot be established by application of our present knowledge. (NCI, 1970, p. 1).

Furthermore, NIOSH has stated that, "it is not possible at the present time to establish an exposure level at which benzene may be regarded to be without danger," a position which it has consistently taken with regard to other carcinogens.

This regulatory policy is consistent with previous OSHA actions to control employee exposure to carcinogens; see, e.g. the preambles to the carcinogen standards, 29 CFR 1910.1003 et seq. (39 FR 3758); the vinyl chloride standard, 29 CFR 1910.1017 (39 FR 35892) and the coke oven emissions standard, 29 CFR 1910.1029 (41 FR 46742). Thus, the level of 1 ppm has been chosen, not as a "safe" or "no effect" level, but on the basis of OSHA's belief, for the reasons set forth in the technical feasibility and economic impact study prepared for OSHA by Arthur D. Little Co., that 1 ppm is the lowest level that generally can be achieved at this time.

(2) *Ceiling limit.* In addition to limiting 8-hour time weighted average exposures to 1 ppm, the emergency standard requires that no employee be exposed to benzene in excess of 5 ppm averaged over any 15-minute period. An employee may be exposed to varying concentrations of benzene during the course of the workday with some periods of exposure above 1 ppm and corresponding periods below 1 ppm. OSHA has determined that the peak excursions permitted under the present standard are not appropriate in regulating exposure to benzene—a human leukemia hazard for which no safe level can be determined. For this reason, the 15-minute ceiling limit of 5 ppm is established to limit the magnitude of brief excursions which might otherwise occur even where the 8-hour time weighted average was not exceeded.

(3) *Dermal and eye exposure limits.* The standard prohibits eye and repeated or prolonged skin exposure to liquid benzene. While studies indicate benzene is not readily absorbed through intact skin, direct contact with liquid benzene can cause blistering and breakage of the skin surface. (46), (47) Under these circumstances, or where the skin is otherwise broken, prolonged or repeated skin contact may result in significant absorption of benzene. In addition, benzene absorp-

tion through the skin may be enhanced when it occurs in combination with other solvents. (48) Once absorbed, the benzene is distributed throughout the body by the blood.

C. Notification of use. The standard requires employers to notify OSHA of the location of workplaces in which benzene is used and to describe the conditions of use and protective measures in effect. This requirement is designed to assure compliance during the effective period of this ETS.

D. Monitoring of exposure. The standard requires employers to monitor each workplace where benzene is present to determine employee exposure. Such determinations may be made by monitoring and measurements which are representative of each employee's exposure to benzene over an 8-hour period. Actual measurements of airborne concentrations of benzene are required in order to determine employee exposure to benzene. However, employers do not have to measure the exposure of each individual employee.

Where the initial measurements reveal benzene exposure to be above the permissible exposure limit, monthly monitoring is required. Measurements which reveal levels of exposure to benzene below the permissible exposure limit require quarterly monitoring.

The results of the exposure measurement program determine what further action must be taken by the employer. In addition to monthly monitoring, measurement of exposures above the permissible exposure limit require the employer to institute controls to reduce the exposure to or below the permissible exposure limit. A monitoring requirement is necessary in the ETS to reduce employee exposure.

In establishing the monitoring and measurement requirements of this standard, OSHA has considered the importance of such activities to identifying exposed employees and their levels of exposure so that appropriate protective measures may be taken. OSHA has also considered the question of the feasibility of immediately complying with the monitoring requirements specified.

Performing the required measurements of employee exposure to benzene will generally involve the use of portable battery-powered air sampling pumps worn by the employee during the sampling period, charcoal tubes for absorption of the benzene, and access to appropriate laboratory facilities for subsequent analysis of the charcoal tube samples. The laboratory analysis would usually be performed using gas chromotographs, a technique commonly available in analytical laboratories and utilized for the analysis of a wide range of air contaminants found in samples of the workplace environment and general community. The standard provides that the initial sampling must be conducted and results obtained within 30 days of the effective date of the standard, which would be almost 50 days following publication of the standard. The standard does not require a separate measurement for each affected employee. It requires only that sufficient measurements are obtained to be representative of the exposure of all affected employees.

OSHA notes that the monitoring requirements will arise principally in the industries engaged in benzene production, gasoline production, and related chemical industries. These industries are generally regarded to be at the forefront of all industries with respect to existing industrial hygiene and occupational health programs. Many of the employers in these industries have extensive professional and technical staffs and established employee health programs which include periodic measurement of employee exposure to benzene. Thus these employers are expected to have little difficulty in complying with the monitoring requirements of this standard. Some of these employers have had to acquire much of the apparatus and equipment required for measuring employee exposure to benzene in order to comply with other occupational health standards previously issued by this Agency. For example, those employers engaged in manufacturing or use of vinyl chloride and polyvinyl chloride and employers engaged in the operation of coke ovens—one source of benzene production, will find that much of the effort made earlier in complying with the standards for vinyl chloride and coke oven emissions will be applicable to the requirements under this standard for measuring employee exposure to benzene.

There are approximately eight manufacturers of suitable sampling pumps. While it is not possible to know the total number of pumps immediately available from these manufacturers, one of the major manufacturers has indicated an ability to deliver 200 immediately and 800 within 45 days. That manufacturer estimated that the entire industry is capable of delivering up to 2,000 pumps in no more than 60 days from now. OSHA believes this capacity is adequate to meet the additional needs of employers who do not presently have a sufficient number of these sampling pumps. Moreover, the standard does not require that the employer own the equipment and do this monitoring himself; the utilization of consultants or contractors is another choice available to many employers.

For the above reasons, the Assistant Secretary concludes that the monitoring and measurement requirements of this emergency standard are feasible.

E. Methods of compliance. The standard requires employee exposure to benzene to be reduced to 1 ppm by engineering controls, work practices and respiratory protection. The emergency standard reflects a preference for the use of engineering controls, work practices and, where possible, substitution because of the greater reliability of these control techniques. (See, for example, the standards on vinyl chloride, § 1910.1017, and coke oven emissions § 1910.1029, and the reasons given therein.)

Thus, employers are required to institute feasible engineering controls and work practices as soon as possible to reduce employee exposure to or below the permissible exposure limits. In operations where engineering controls and work practices do not completely reduce exposure to the permissible level, they must still be implemented to reduce exposures to the lowest practicable level and supplemented by respirators.

OSHA recognizes that initial compliance may involve the use of respirators in many instances until engineering controls are installed and work practices initiated.

Based on a review of the Arthur D. Little Co. study and data furnished by respirator manufacturers, OSHA has determined that the availability of respirators of the required types, especially the air-purifying respirators and replacement cartridges, is adequate to meet the needs of employers who will require them for compliance with the ETS. For example, there are several manufacturers of air-purifying respirators for use against benzene. One of these manufacturers has indicated that it currently has in stock 100,000 replacement cartridges more than normal order requirements, can deliver more than 250,000 cartridges per month, and is presently increasing production capacity for this type of respirator. Additionally, OSHA is aware that respirators are currently available for use by employees in many job categories in the industries covered by this standard, such as the petroleum refining, petrochemical, chemical, and related industries.

OSHA estimates that approximately 30,000 of the 150,000 employees affected by this standard would have to be furnished respirators for use some of the time during the initial period of compliance with this standard. In view of the current existence of suitable respirators in many workplaces where they would be needed and the ability of the respirator manufacturers and suppliers to supply promptly on receipt of order additional respirators needed to comply, OSHA concludes that the respirator requirements of this standard are feasible.

F. Medical surveillance. The standard requires employers to institute a limited program of medical surveillance for all employees exposed to benzene. The purposes of these medical surveillance requirements are to determine the effects of exposure on the blood forming systems of the employees, to detect blood abnormalities, and to ensure that symptoms of overexposure to benzene are recognized as early as possible. The standard provides that this medical testing shall be conducted within 30 days of the effective date of the standard and quarterly thereafter. The medical surveillance requirements are limited to those minimum tests considered necessary for the emergency standard. (41) The standard also requires a medical history to be taken for every employee who may be exposed to benzene.

Facilities for performing such routine blood tests are readily available in all parts of the country and OSHA has concluded that compliance with this limited medical testing requirement is immediately feasible.

Following the medical examination, the employer must obtain a written opinion from the examining physician stating whether the employee has any medical condition that would place him at increased risk to his health from exposure to benzene. The employer must provide a copy of the physician's opinion to the affected employee. Employees are not required by the standard to submit to the medical surveillance offered under this provision.

G. *Employee education and training.* Information and training are important to protect employees from workplace cancer hazards. Appropriate training of employees can result in immediate benefits in terms of reduced exposures. To be effective, an employee education system must fully inform the employee of the specific hazards associated with the work environment. For this reason, the employer is required to inform each employee who is assigned to work in the presence of benzene about the specific operations where benzene exposure may occur and about proper procedures to avoid unnecessary exposure. The required training program must, among other things, advise employees of the signs and symptoms of exposure to benzene, the purpose of the medical tests, and the purpose, proper use, and limitation of respirators.

H. *Signs.* It is important for the protection of employees that appropriate forms of warning, as necessary, be used to inform employees of the hazards to which they are exposed in the course of their employment.

In light of the grave danger posed by exposure to benzene, OSHA believes that signs are necessary in addition to the periodic training program for informing employees of the carcinogenic hazard of benzene exposure.

I. *Recordkeeping.* The standard requires a limited amount of recordkeeping. Employers must maintain exposure measurement records and medical records. Such records must be maintained during the period of the emergency standard. Thereafter, employers will be subject to the long-term recordkeeping requirements included in the final standard promulgated under section 6 (b) of the Act.

J. *Appendixes.* Three appendixes have been attached to the standard for informational purposes. These appendixes do not impose any additional requirements on the employer.

V.—REFERENCES

The studies and other data listed below, as well as the additional material referred to in this document, represent the principal sources upon which the emergency standard is based. A complete set of the references is available for inspection and copying at the OSHA Technical Data Center, Room S6212, U.S. Department of Labor, 3rd Street and Constitution Avenue NW., Washington, D.C. 20210.

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VI. Environmental and Economic Impacts

The National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and regulations issued thereunder (29 CFR Part 1999) require that Federal agencies assess their proposed major actions to determine whether a significant impact on the quality of the human environment may result, and if necessary to prepare an environmental impact statement. An environmental impact statement on the regulation of occupational exposure to benzene will be prepared and made available as required during the rulemaking proceedings under section 6(b) of the Act. Because of the emergency nature of this standard, no environmental impact statement can be prepared or is required for the emergency temporary standard. In addition, notice is hereby given that an economic impact analysis under Executive Order 11949 (42 FR 1017) and applicable procedures will be prepared and made available prior to the promulgation

of any permanent standard resulting from this emergency temporary standard. The preliminary economic and technological feasibility study done by Arthur D. Little indicates that the emergency standard is feasible.

VIII—PUBLIC PARTICIPATION—NOTICE OF HEARING

Pursuant to section 6(c)(3) of the Act, this ETS as published also serves as a proposal for a permanent rule. It is OSHA's intention to develop and publish a more comprehensive proposal in the very near future which will contain additional provisions and some modifications of this emergency standard. Since the comprehensive proposal will be based on the emergency standard and since the emergency nature of the proceeding and the requirements of section 6(c) will necessitate expedited treatment throughout the development of the final standard on benzene, interested parties should begin preparation of their written comments and oral presentations immediately.

Interested persons are invited to submit written data, views and arguments with respect to this ETS and the supplementary proposal to be published shortly. These comments must be postmarked on or before June 20, 1977 and submitted in quadruplicate to the Docket Officer, Docket No. H–059, Room S6212, U.S. Department of Labor, 3rd Street and Constitution Avenue, NW., Washington, D.C. 20210. Written submissions must clearly identify the provisions of the ETS and the proposal which are addressed and the position taken with respect to each issue therein. The data, views and arguments that are submitted will be available for public inspection and copying at the above address. All timely written submissions received will be made a part of the record of this proceeding.

Pursuant to section 6(b)(3) of the Act, an opportunity to submit oral testimony concerning the issues raised by the ETS and the proposed standard, including the economic and environmental impacts, will be provided at an informal public hearing scheduled to begin at 9:30 a.m. on July 12, 1977, in the New Department of Labor Auditorium, New Department of Labor Building, 3rd Street and Constitution Avenue, NW., Washington, D.C. 20210.

NOTICES OF INTENTION TO APPEAR

All persons desiring to participate at the hearing, must file in quadruplicate a notice of intention to appear, postmarked on on before June 20, 1977 with the OSHA Committee Management Office, Docket No. H–059, Room N–3635, U.S. Department of Labor, 3rd Street and Constitution Avenue, NW., Washington, D.C. 20210 (telephone: (202) 523–8024).

The notices of intention to appear, which will be available for inspection and copying at the OSHA Committee Management Office, must contain the following information:

(1) The name, address, and telephone number of each person to appear;

(2) The capacity in which the person will appear;

(3) The approximate amount of time requested for the presentation;

(4) The specific issues that will be addressed;

(5) A detailed statement of the position that will be taken with respect to each issue addressed; and

(6) Whether the party intends to submit documentary evidence, and if so, a brief summary of that evidence.

FILING OF TESTIMONY AND EVIDENCE BEFORE HEARING

Any party requesting more than 15 minutes for a presentation at the hearing, or who will submit documentary evidence, must provide in quadruplicate the complete text of his testimony including any documentary evidence to be presented at the hearing, to the OSHA Committee Management Office where it will be available for inspection and copying. This material must be received by July 5, 1977. Each such submission will be reviewed in light of the amount of time requested in the notice of intention to appear. In those instances where the information contained in the submission does not justify the amount of time requested, a more appropriate amount of time will be allocated and the participant will be notified of that fact.

Any party who has not substantially complied with this requirement may be limited to a 15 minute presentation, and may be requested to return for questioning at a later time.

CONDUCT OF HEARINGS

The hearing will commence at 9:30 a.m. on July 12, 1977, with resolution of any procedural matters relating to the proceeding. The hearing will be conducted in accordance with 29 CFR Part 1911. In view of the emergency nature of this rulemaking proceeding, the hearing will be conducted in as expedited a manner as possible, consistent with a full development of the record and the rights of the parties.

The hearing will be presided over by an Administrative Law Judge who will have all the powers necessary or appropriate to conduct a full and fair informal hearing as provided in 29 CFR Part 1911. Following the close of the hearing or of any posthearing comment period, the presiding Administrative Law Judge will certify the record to the Assistant Secretary of Labor for Occupational Safety and Health. The proposal will be reviewed in light of all oral and written submissions received as part of the record, and a standard will be issued based on the entire record in this proceeding.

AUTHORITY

This document was prepared under the direction of Eula Bingham, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 300 Constitution Avenue, NW., Room S–2315, Washington, D.C. (202–523–8361).

Accordingly, pursuant to sections 6(c) and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1596, 1599, 29 U.S.C. 655, 657), the Secretary of Labor's Order No. 8–76, and 29 CFR Part 1911, Part 1910 of Title 29 of the Code of Federal Regulations is hereby amended by adding a new § 1910.1028 as set forth below. In addition, pursuant to section 4(b)(2) of the Act (84 Stat. 1592; 29 U.S.C. 653), the standard in the new § 1910.1028 is determined to be more effective than the corresponding standards now in Subpart B of Part 1910, in Parts 1915, 1916, 1917, 1918 and 1926 of Title 29, Code of Federal Regulations. Therefore, these corresponding standards are superseded by the new standard in § 1910.1028. These amendments are effective May 31, 1977.

Signed at Washington, D.C., this 29th day of April 1977.

EULA BINGHAM,
Assistant Secretary of Labor.

Part 1910 of Title 29 of the Code of Federal Regulations is therefore amended as follows:

1. A new § 1910.20 is added to 29 CFR Part 1910 to read as follows:

§ 1910.20 Benzene.

Section 1910.1028 shall apply to the exposure of every employee to benzene in every employment and place of employment covered by §§ 1910.12, 1910.13, 1910.14, 1910.15, or § 1910.16, in lieu of any different standard on exposure to benzene which would otherwise be applicable by virtue of any of those sections.

§ 1910.1000 [Amended]

2. Table Z–2 of § 1910.1000 is amended by adding a footnote 1 following the words "Benzene (Z37.4–1969)" and by adding the following below Table Z–2:

Occupational exposures to benzene are subject to the requirements of § 1910.1028 except as specifically exempted by § 1910.1028(a). Exposures exempted by § 1910.1028(a) are covered by this section.

3. Part 1910 of Title 29 of the Code of Federal Regulations is amended by adding thereto a new § 1910.1028 to read as follows:

§ 1910.1028 Benzene.

(a) *Scope and application.* (1) This section applies to the production, reaction, release, packaging, repackaging, storage, transportation, handling, or use of benzene.

(2) This section does not apply: (i) To retail automotive service stations; or (ii) where the exposure to benzene is only from liquid mixtures containing 1 percent or less of benzene by volume, or the vapors released from these liquids.

(b) *Definitions.* "Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, or designee.

"Benzene" (C_6H_6) (CAS Registry No. 000071432), means benzene, or a mixture of liquids containing benzene, or the benzene vapor released by these liquids.

"Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or designee.

"OSHA Area Office" means the Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the employer's establishment is located.

(c) *Exposure limits.*—(1) *Permissible airborne exposure limits.* (i) The employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 1 part benzene per million parts of air (1 ppm), as an 8-hour time-weighted average.

(ii) The employer shall assure that no employee is exposed to an airborne concentration of benzene in excess of 5 ppm as averaged over any 15 minute period.

(2) *Dermal and eye exposure limit.* The employer shall assure that no employee is exposed to eye contact or repeated skin contact with benzene.

(d) *Notification of use.* Within 30 days of the effective date of this section, every employer who has a place of employment where benzene is present, shall report the following information to the nearest OSHA area office for each such establishment:

(1) The address and location of each establishment where employee exposure to benzene occurs;

(2) A brief description of each process or operation which may result in employee exposure to benzene;

(3) The number of employees engaged in each process or operation which may result in exposure to benzene and an estimate of the frequency and degree of exposure that results; and

(4) A brief description of the employee safety and health program as it relates to limitation of employee exposure to benzene.

(e) *Exposure monitoring and measurement.*—(1) *Initial monitoring.* (i) Each employer who has a place of employment where benzene is present, shall monitor each such workplace and work operation to determine the airborne concentrations of benzene to which employees may be exposed. This determination shall be made by monitoring and measurements which are representative of each employee's exposure to benzene over an 8-hour period.

(ii) Each employer, who has a place of employment in which benzene is present, shall inspect each workplace and work operation to determine if any employee may be exposed to benzene through eye contact or repeated skin contact.

(2) *Frequency of monitoring.* The monitoring required under paragraph (e)(1) of this section shall be conducted, and the results obtained, within thirty days of the effective date of this section and thereafter repeated quarterly for employees whose exposure is found to be less than 1 ppm, and monthly for those employees whose exposure is found to be in excess of the permissible exposure limit. The employer shall continue monthly measurements until at least two consecutive measurements taken at least seven (7) days apart are below the permissible exposure limit, and thereafter the employer shall measure quarterly.

(3) *Additional monitoring.* Whenever there has been a production, process, or control change which may result in new or additional exposure to benzene, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to benzene, additional monitoring which complies with paragraph (e)(1) of this section shall be made.

(4) *Employee notification.* (i) Within 5 working days after the receipt of measurement results, the employer shall notify each employee in writing of the exposure measurements which represent that employee's exposure.

(ii) Where the results reveal the employee's exposure to be over the permissible exposure limit, this notification shall also include the corrective action being taken to reduce exposure to or below the permissible exposure limit.

(5) *Accuracy of measurement.* The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than plus or minus 25 percent for concentrations of benzene greater than or equal to 1 ppm.

(6) *Employee exposure.* For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(f) *Methods of compliance.* The employer shall control employee exposures to airborne concentrations of benzene to or below the permissible exposure limit, and shall protect against employee exposure to eye or repeated skin contact with benzene, by engineering controls, work practices and personal protective devices and equipment, as follows:

(1) *Engineering controls.* The employer shall develop and implement, as soon as possible, feasible engineering controls to reduce the airborne concentration of benzene to or below the permissible exposure limit.

(2) *Work practices.* The employer shall examine each work area in which benzene is present and shall institute, as soon as possible, work practices to reduce employee exposure to benzene to or below the permissible exposure limit. The work practices shall be described in writing and shall include, among other things, the following:

(i) Limiting access to work areas where benzene is present to authorized personnel only;

(ii) Prohibiting smoking and the consumption of food and beverages in work areas where benzene is present; and

(iii) Establishing good maintenance and housekeeping including the prompt cleanup of spills, repair of leaks, etc.

(3) *Respiratory projection.* Whenever engineering and work practice controls which can be instituted are not sufficient to reduce exposures to or below the permissible exposure limit, they shall be used nontheless to reduce exposure to the lowest practicable level, and shall be supplemented by the use of respirators in accordance with paragraph (g) of this section.

(g) *Respirators.*—(1) *Required use.* The employer shall assure that respirators are used where required under this section to reduce employee exposure to or below the permissible exposure limit, and in emergencies.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select and provide the appropriate respirator from Table I below and shall assure that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those approved by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

TABLE I

RESPIRATORY PROTECTION FOR BENZENE

Concentration of benzene or condition of use	*Respirator type*
(a) Less than or equal to 10 ppm	(1) Chemical cartridge respirator with organic vapor cartridges and half mask; or (2) Any supplied air respirator with half mask.
(b) Less than or equal to 50 ppm	(1) Chemical cartridge respirator with organic vapor cartridges and full facepiece; or (2) Any supplied air respirator with full facepiece; or (3) Any organic vapor gas mask; or (4) Any self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 1,000 ppm	(1) Supplied air respirator with half mask in positive pressure mode.
(d) Less than or equal to 2,000 ppm	(1) Supplied air respirator with full facepiece, helmet, or hood, in positive pressure mode.
(e) Less than or equal to 10,000 ppm	(1) Supplied air respirator and auxiliary self-contained facepiece in positive pressure mode; or (2) Open circuit self-contained breathing apparatus with full facepiece in positive pressure mode.
(f) Escape	(1) Any organic vapor gas mask; or (2) Any self-contained breathing apparatus with full facepiece.

(3) *Respirator program.* The employer shall institute a respiratory protection program in accordance with § 1910.134 (b), (d), (e) and (f).

(4) Where air-purifying respirators are used (cartridge, canister or gas mask), the air-purifying canisters or cartridges shall be replaced prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first.

(h) *Protective clothing and equipment.* Where eye or repeated skin contact with liquid benzene may occur, employers shall provide and assure that employees wear impermeable protective clothing and appropriate equipment to protect the area of the body likely to come in contact with liquid benzene.

(i) *Medical surveillance.* (1) Each employer shall make available a medical surveillance program for all employees who are or will be exposed to benzene. The medical surveillance program shall consist of:

(i) A history which includes past work exposures to benzene or any other hematologic toxins, a family history of hematological neoplasms, a history of blood dyscrasias including genetically related hemoglobin alterations, bleeding abnormalities, abnormal function of formed blood elements, a history of renal or liver dysfunction, a history of drugs routinely taken, alcoholic intake and systemic infections;

(ii) A complete blood count including a differential white blood cell count; and

(iii) Additional tests shall be conducted where, in the opinion of the examining physician, alterations in the components of the blood are related to benzene exposure.

(2) All medical procedures shall be performed by or under the supervision of a licensed physician, and shall be provided by the employer without cost to the employee.

(3) Medical surveillance and testing of each employee shall be conducted within thirty days of the effective date of this section, and quarterly thereafter. If an employee is accidently or otherwise exposed to benzene by ingestion, inhalation, skin or eye contact, or for any reason, an employee develops signs and symptoms commonly associated with exposure to benzene, the employer shall provide appropriate medical examinations and emergency treatment.

(4) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its appendixes;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's representative exposure level; and

(iv) A description of any personal protective equipment used or to be used.

(5) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(a) The results of the medical testing;

(b) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to benzene;

(c) Any recommended limitations upon the employee's exposure to benzene or upon the use of protective clothing and equipment such as respirators; and

(d) A statement that the employee has been informed by the physician of any medical conditions which require further examination or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(j) *Employee information and training.*—(1) *Training program.* Within fifteen days of the effective date of this section, the employer shall provide a training program for employees assigned to workplace areas where benzene is present and shall assure that each affected employee is informed of the following:

(i) The information contained in the substance data sheet for benzene which is contained in Appendix A of this section;

(ii) The quantity, location, manner of use, release or storage of benzene and the specific nature of operations which could result in exposure above the permissible exposure limit, as well as necessary protective steps;

(iii) The purpose, proper use, and limitation of respiratory devices as specified in § 1910.134;

(iv) The purpose and a description of the medical testing program required by paragraph (i) of this section and the information contained in Appendix C of this section; and

(v) The contents of this standard.

(2) *Access to training materials.* (i) The employer shall make a copy of this standard and its appendixes readily available to all affected employees.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(k) *Signs.* (1) The employer shall post signs to clearly designate all work areas where benzene may be present, bearing the legend:

DANGER
BENZENE
CANCER HAZARD

(2) Where the permissible exposure limit is exceeded, the signs shall also include the legend: Respirator required.

(3) The employer shall assure that no statement appear on or near any required sign which contradicts or detracts from the required information.

(l) *Recordkeeping.*—(1) *Exposure measurements.* The employer shall establish and maintain an accurate record of all measurements required by paragraph (e) of this section.

(i) This record shall include:

(a) The dates, number, duration and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposures;

(b) A description of the sampling and analytical methods used;

(c) Type of respiratory protective devices worn, if any; and

(d) Name, social security number, and job classification of the employee monitored and all other employees whose exposure the measurement is intended to represent.

(ii) This record shall be maintained during the effective period of this section.

(2) *Medical surveillance.* The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (i) of this section.

(i) This record shall include:

(a) A copy of the physician's written opinion;

(b) Any employee medical complaints related to exposure to benzene; and

(c) A copy of the information provided to the physician as required by paragraph (i) (4) of this section;

(ii) This record shall be maintained during the effective period of this section.

(3) *Availability.* (i) All records required to be maintained by this section shall be made available upon request to the Assistant Secretary and the Director for examination and copying.

(ii) Employee exposure measurement records as required by this section shall be made available for examination and copying to affected employees, and their designated representatives.

(iii) Former employees and the employees' designated representatives shall have access to such records as will indicate their own exposure to benzene.

(iv) Employee medical records required to be maintained by this section shall be made available upon request for examination and copying to a physician designated by the affected employee or former employee.

(m) *Observation of monitoring.*—(1) *Employee observation.* The employer shall provide affected employees, or their designated representatives, an opportunity to observe any measuring or monitoring of employee exposure to benzene conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) When observation of the measuring or monitoring of employee exposure to benzene requires entry into an area where the use of protective clothing and equipment or respirators is required, the employer shall provide the observer with personal protective devices required to be worn by employees working in the area, assure the use of such equipment, and require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the measurement, observers shall be entitled to:

(a) Receive an explanation of the measurement procedures;

(b) Observe all steps related to the measurement of airborne concentrations of benzene performed at the place of exposure; and

(c) Record the results obtained.

(n) Effective date: This section shall become effective May 21, 1977.

(o) *Appendixes.* The information contained in the appendixes is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

I. SUBSTANCE IDENTIFICATION

APPENDIX A—SUBSTANCE SAFETY DATA SHEET

BENZENE

A. *Substance.* Benzene.

B. *Permissible Exposure.* Except as to retail gasoline stations and operations which use liquids containing benzene in amounts greater than 1% by volume, or the benzene vapor released by any such liquids.

1. *Airborne.* 1 part of benzene vapor per million parts of air (1 ppm); time-weighted average (TWA) for an 8-hour workday for a 40-hour week, with a ceiling concentration of 5 ppm.

2. *Dermal.* Eye contact and repeated skin contact with liquid benzene shall be prohibited.

C. *Appearance and odor.* Benzene is a clear, colorless liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazzard.

II. HEALTH HAZARD DATA

A. *Ways in which the benzene affects your health.* Benzene can affect your health if you inhale it, or if it comes in contact with your skin or eyes. Benzene may also be harmful if you happen to swallow it.

B. *Effects of overexposure.* 1. Short-term (acute) overexposure: If you are overexposed to high concentrations of benzene, well above the levels where its odors are first recognizable, you may feel breathless, irritable, euphoric, or giddy; you may experience irritation in eyes, nose, and respiratory tract. You may develop a headache, feel dizzy, nauseous, or experience unsteadiness in walking. Severe exposures may lead to convulsions.

2. Long-term (chronic) exposure: Repeated and prolonged exposure of benzene may cause headache, fatigue, exhaustion, tendency to bleed, nervousness, sleeplessness, shortness of breath, and serious blood disorders, including leukemia.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. *Respirators.* Respirators are required for those operations in which engineering controls or work practice controls are not available to reduce exposure to the permissible level. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) seal of approval. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. *Protective Clothing.* You must wear impervious protective clothing (such as boots, gloves, sleeves, aprons, etc.) over any parts of your body that could be repeatedly exposed to liquid benzene.

C. *Eye and Face Protection.* You must wear splash proof safety goggles if it is possible that benzene may get into your eyes. In addition, you should wear a face shield if your face could be splashed with benzene liquid.

IV. EMERGENCY AND FIRST AID PROCEDURES

A. *Eye and face exposure.* If benzene is splashed in your eyes, wash it out immediately with large amounts of water. Call a doctor as soon as possible.

B. *Skin exposure.* If benzene is spilled on your clothing or skin, remove the contaminated clotning and wash the exposed skin with large amounts of water and soap immediately. Wash contaminated clothing before you wear it again.

C. *Breathing.* If you or any other person breathes in large amounts of benzene, get the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call a doctor as soon as possible.

D. *Swallowing.* If benzene has been swallowed and the patient is conscious, do not induce vomiting. Call a doctor immediately.

V. MEDICAL REQUIREMENTS

If you are exposed to benzene your employer is required to provide the following medical procedures within thirty days of the effective date of this standard, consisting of a medical history and laboratory tests. These tests shall be provided without cost to you.

VII. OBSERVATION OF MONITORING

Your employer is required to perform measurements that are representative of your exposure to benzene and you are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, observe the steps taken in the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with, and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to see the records of measurements of your exposure to benzene upon request to your employer. Your medical examination records can be furnished to your physician upon request to your employer.

IX. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

Benzene liquid is highly flammable. It should be stored in tightly closed containers in a cool, well ventilated area. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. You should use non-sparking tools when opening or closing benzene containers. You must ground or bond metal benzene containers. Fire extinguishers, where provided, must be readily available and you should know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored. Ask your supervisor where benzene is used on your work area and for additional plant safety rules.

APPENDIX B—SUBSTANCE TECHNICAL GUIDELINES

BENZENE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. *Synonyms.* Benzol, benzole, coal naptha, cyclohexatriene, phene, phenyl hydride, pyrobensol, (Benzin, petroleum benzin, and benzine, do not contain benzene).

2. *Formula.* C_6H_6 (CAS Registry Number: 0000071432)

B. Physical Data

1. Boiling point (760 mm Hg): 80.1 C (176F).

2. Specific Gravity (water=1) :0.879.

3. Vapor Density (air=1) :2.7.

4. Melting Point: 5/5 C (42F).

5. Vapor Pressure at 20 C (68F) :75 mm Hg.

6. Solubility in Water: .06%.

7. Evaporation Rate (ether=1) :2.8.

8. Appearance and Odor: Clear, colorless liquid with a distinctive sweet odor.

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. *Fire.* 1. Flash Point (closed cup): —11 C (12F).

2. Autoignition Temperature: 580° C (1076F).

3. Flammable Limits in Air, % by Volume: Lower: 1.3% Upper: 7.1%.

4. Extinguishing Media: Carbon dioxide, dry chemical, or foam.

5. Special Fire-Fighting Procedures: Do not use solid stream of water, since stream will scatter and spread fire. Water spray can be used to keep fire exposed containers cool.

6. Unusual fire and explosion hazards: Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Where liquid or vapor may be released, such areas shall be considered as hazardous locations. Benzene vapors are heavier than air; thus the vapors may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

7. Benzene is classified as a 1 B flammable liquid for the purpose of conforming to the requirements of 29 CFR 1910.106. A concentration exceeding 3250 ppm is considered a potential fire or explosion hazard. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered Class 1 Group D for the purposes of conforming to the requirement of 29 CFR 1910.309.

B. *Reactivity.* 1. Conditions contributing to instability: Heat.

2. Incompatibility: Heat and oxidising materials.

3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide).

III. SPILL AND LEAK PROCEDURES

A. *Steps to be taken if the material is released or spilled.* Large amounts of water should be used to flush the spills. Do not flush benzene into confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

B. *Waste Disposal Method.* Disposal methods must conform to other jurisdictional regulations. If allowed, benzene may be disposed of: (a) By absorbing it in dry sand or earth and disposing in a sanitary land fill; (b) if small quantities, by removing it to a safe location from buildings or other combustible sources, pouring it in dry sand or earth and cautiously igniting it; (c) if large quantities, by atomizing it in a suitable combustion chamber.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. Normal Monitoring Program: Measurements taken for the purpose of determining employee exposure are best taken such that the representive average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five (5) measurements is taken in a random manner over the 8-hour work shift. Random sampling means that

any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. NIOSH recommends that samples be collected at a sampling rate of one liter per minute for a minimum of two hours. Air samples should be taken in the employee's breathing zone (air that would nearly represent that inhaled by the employee). Sampling and analysis should be performed by gas absorption tubes with subsequent chemical analysis, by gas chromatography of those areas most likely to represent the highest airborne concentration of benzene where employees are exposed. Methods meeting the prescribed accuracy and precision requirements are available in the "NIOSH Manual of Analytical Methods."

V. MISCELLANEOUS PRECAUTIONS

A. High Exposures to benzene can occur when transferring the liquid from one container to another. Such operations should be well ventilated and good work practices should be established to avoid spills.

B. Non-sparking tools should be used to open benzene containers which should be effectively grounded and bonded prior to opening and pouring.

C. Employers should advise employees of all plant areas and operations where exposure to benzene could occur. A few of the common operations in which high exposures to benzene may be encountered are: manufacture of styrene, phenol, cyclohexane, pesticides, and detergents.

APPENDIX C—MEDICAL SURVEILLANCE GUIDELINES FOR BENZENE

I. ROUTE OF ENTRY

Inhalation; possible skin absorption.

II. TOXICOLOGY

Benzene is primarily an inhalation hazard. Systemic absorption cause depression of the hematopoietic system. Inhalation of high concentrations can affect the central nervous system function. Aspiration of small amounts of liquid benzene immediately causes pulmonary edema and hemorrhage of pulmonary tissue. Skin absorption through intact skin is negligible. However, absorption will be accelerated in the case of injured skin, and benzene may be more readily absorbed if it is present in a mixture or as a contaminate in solvents which are readily absorbed. Defatting action of benzene may produce primary irritation upon repeated or prolonged contact with the skin. High concentrations are irritating to the mucous membranes of the eyes, nose, and respiratory tract.

III. SIGNS AND SYMPTOMS

Benzene is poorly absorbed through the skin, however, direct contact may cause erythema or blistering. Repeated or prolonged contact may result in drying, scaling, dermatitis, or precipitate development of secondary skin infections. Local effects of benzene vapor or liquid on the eye are slight. Only at very high concentrations is there any smarting sensation in the eye. Droplet contamination of the eye by benzene causes a moderate burning sensation, but only slight transient injury of the epithelial cell, with the eye recovering rapidly. Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation, and/or giddiness, followed by a period of depression, drowsiness, fatigue, or vertigo. There may be sensation of tightness in the chest accompanied by breathlessness and ultimately the victim may lose consciousness. Convulsions and tremors occur frequently, and death may follow from respiratory paralysis or circulatory collapse in a few minutes to several hours following severe exposures. The insidious and often irreversible effect on the blood-forming system of prolonged exposure to small quantities of benzene vapor is of extreme importance. These effects have been noted to occur at concentrations of benzene which may not cause irritation of mucous membranes, or any unpleasant sensory effects. Early signs and symptoms of benzene morbidity are varied and vague, and not specific for benzene exposure. Subjective complaints of headache, dizziness, and loss of appetite may precede or procede clinical symptomology. Bleeding from the nose, gums, or mucous membranes and the development of purpuric spots may occur as the condition progresses. Rapid pulse and low blood pressure in addition to a physical appearance of anemia may accompany a subjective complaint of shortness of breath. Clinical evidence of leucopenia and anemia are the most common abnormalities reported, however, macrocytosis and thrombocytopenia are also frequently present. Bone marrow may appear normal, aplastic, or hyperplastic and may not in all situations correlate with peripheral blood findings indicating hypo-hyper-activity of blood forming tissues. There are great variations in the susceptibility to benzene morbidity which prohibits the identification of "typical" blood picture. The effects of prolonged benzene exposure may appear after several weeks or years after the actual exposure has ceased. Development of leukemia also results from exposure to benzene.

IV. TREATMENT

Remove from exposure immediately, give oxygen or artificial resuscitation if indicated. Flush eyes and wash contaminated skin. Symptoms of non-specific nervous disturbances may persist following severe exposures. Recovery from mild exposures is usually rapid and complete.

V. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. *Other considerations.* Benzene can cause both acute and chronic effects. It is important that the physician become familiar with the operating conditions in which exposure to benzene occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. *Surveillance and screening.* Medical histories and laboratory examinations are required for each employee subject to exposure to benzene. The employer must screen employees for history of certain medical conditions (listed below) which might place the employee at increased risk from exposure.

1. *Liver disease.* The primary site of biotransformation and detoxification of benzene is the liver. Liver dysfunctions likely to inhibit the conjugation reactions will tend to promote the toxic actions of benzene. These precautions should be considered before exposing persons with impaired liver function to benzene vapors.

2. *Renal disease.* Although benzene is not known as a kidney toxin the importance of the organ in the elimination of toxic substances and metabolites justifies special consideration in those with possible impairment of renal function.

3. *Skin disease.* Benzene is a defatting agent and can cause dermatitis on prolonged exposure. Persons with preexisting skin disorders may be more susceptible to the effects of benzene.

4. *Blood dyscrasias.* Benzene is a hematopoietic depressant. Persons with existing blood disorders may be more susceptible to the effects of benzene.

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(Secs. 4, 6, 8, 84 Stat. 1593, 1599 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order 8–76 (41 FR 25059); 29 CFR Part 1911.)

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